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(54) **METHOD AND APPARATUS FOR SUPPORTING UE-TO-NETWORK RELAY COMMUNICATION IN A WIRELESS COMMUNICATION SYSTEM**

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Related U.S. Application Data

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(51) **Int. Cl.**

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H04W 76/19 (2018.01)
H04W 76/14 (2018.01)
H04W 92/18 (2009.01)
H04W 88/04 (2009.01)

(52) **U.S. Cl.**

CPC **H04W 76/19** (2018.02); **H04W 76/14** (2018.02); **H04W 88/04** (2013.01); **H04W 92/18** (2013.01)

(58) **Field of Classification Search**

CPC combination set(s) only.
See application file for complete search history.

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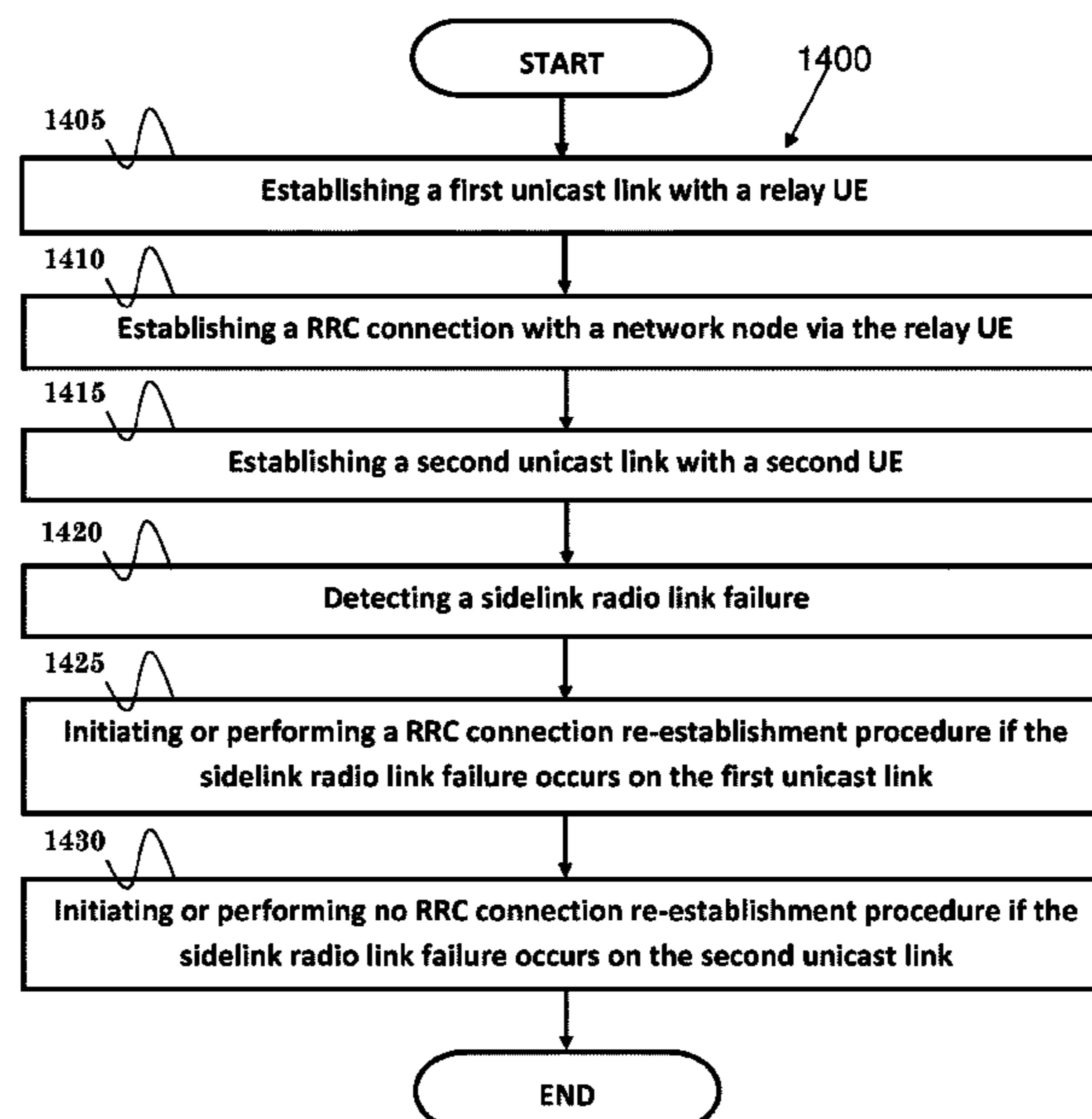
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(57) **ABSTRACT**

A method and device are disclosed from the perspective of a remote UE. In one embodiment, the method includes the remote UE establishing a first unicast link with a relay UE. The method also includes the remote UE establishing a Radio Resource Control (RRC) connection with a network node via the relay UE. The method further includes the remote UE establishing a second unicast link with a second UE. In addition, the method includes the remote UE detecting a sidelink radio link failure. Furthermore, the method includes the remote UE initiating or performing a RRC connection re-establishment procedure if the sidelink radio link failure occurs on the first unicast link. The method also includes the remote UE initiating or performing a Sidelink UE Information procedure if the sidelink radio link failure occurs on the second unicast link.

18 Claims, 13 Drawing Sheets



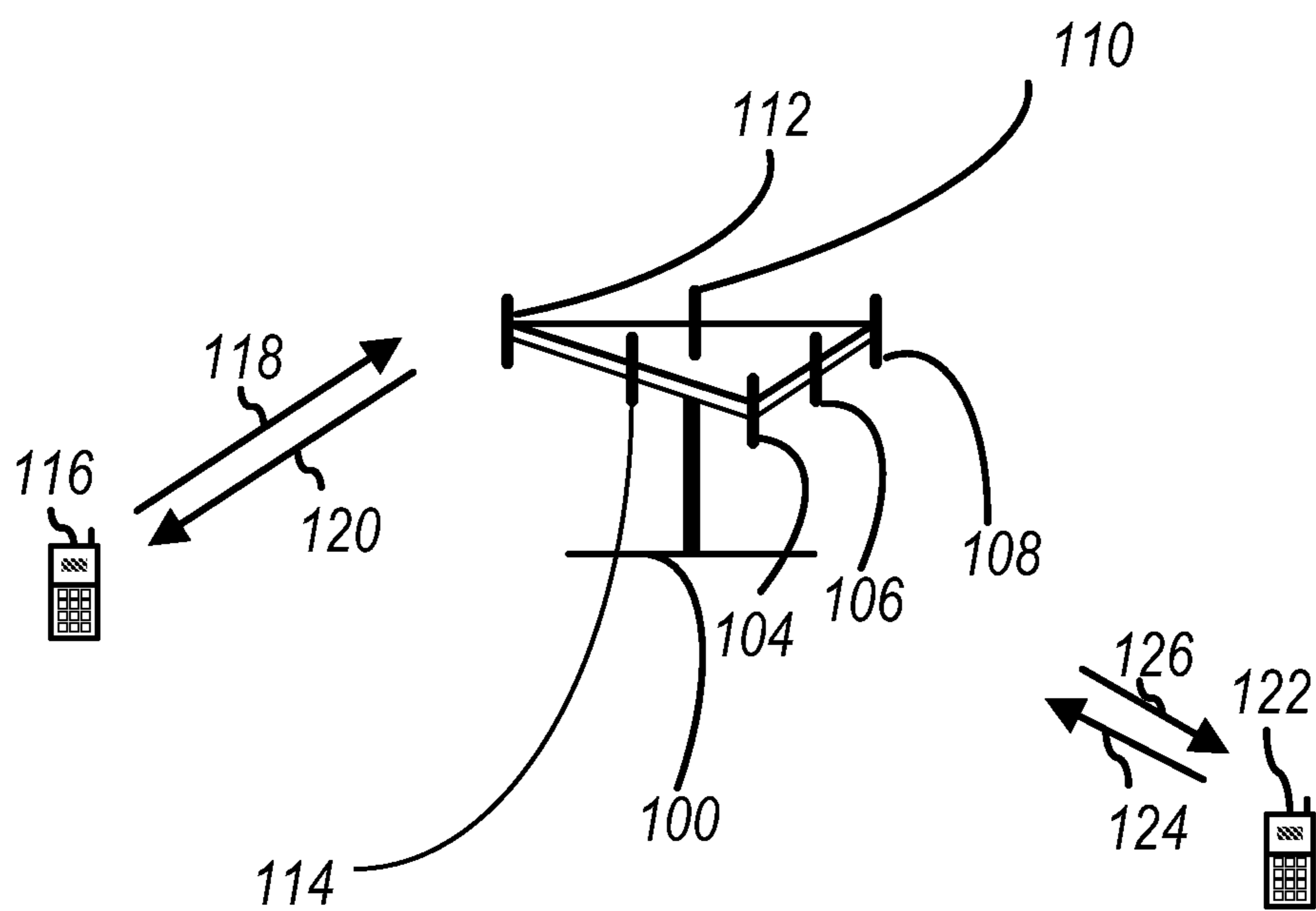


FIG. 1

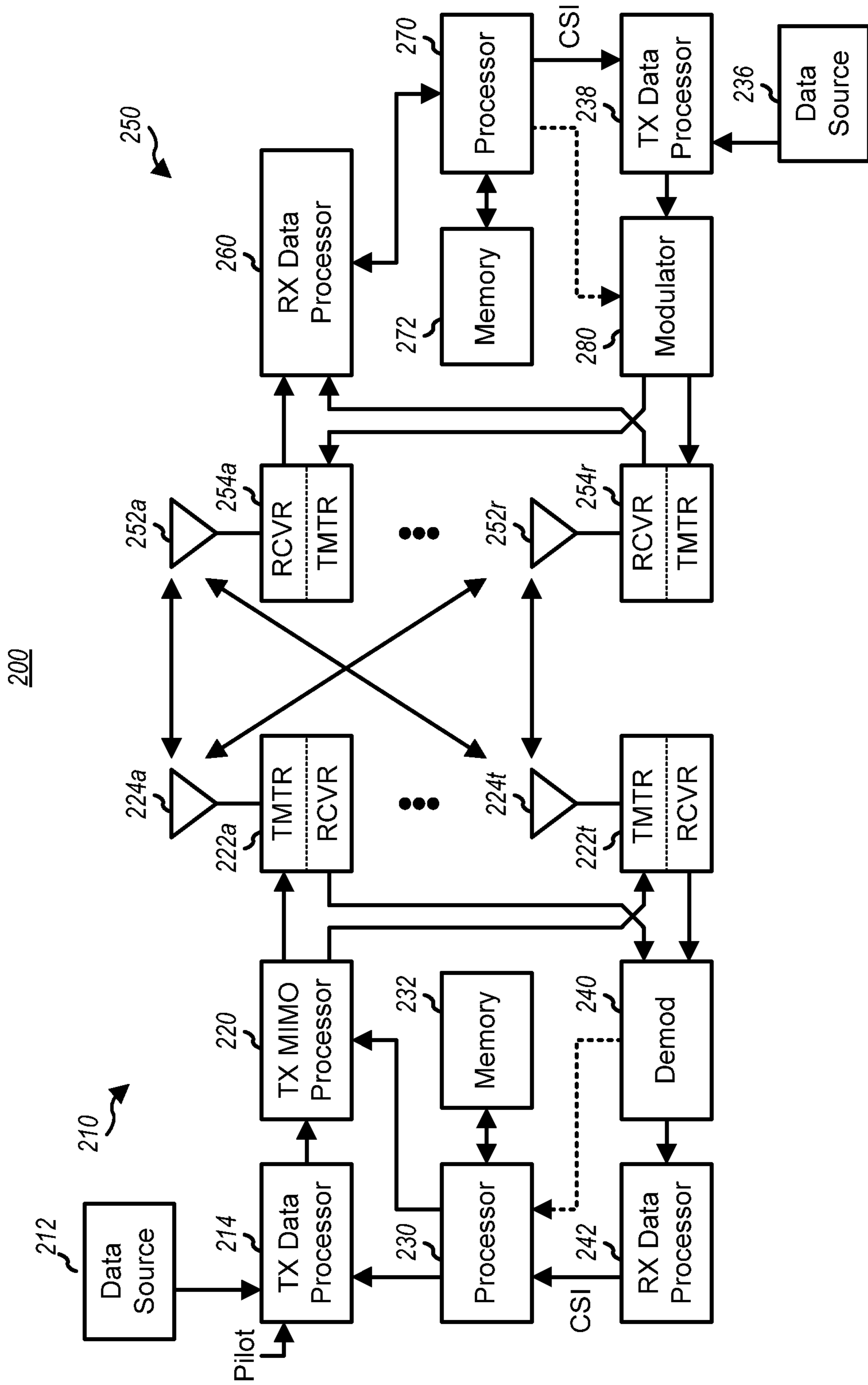


FIG. 2

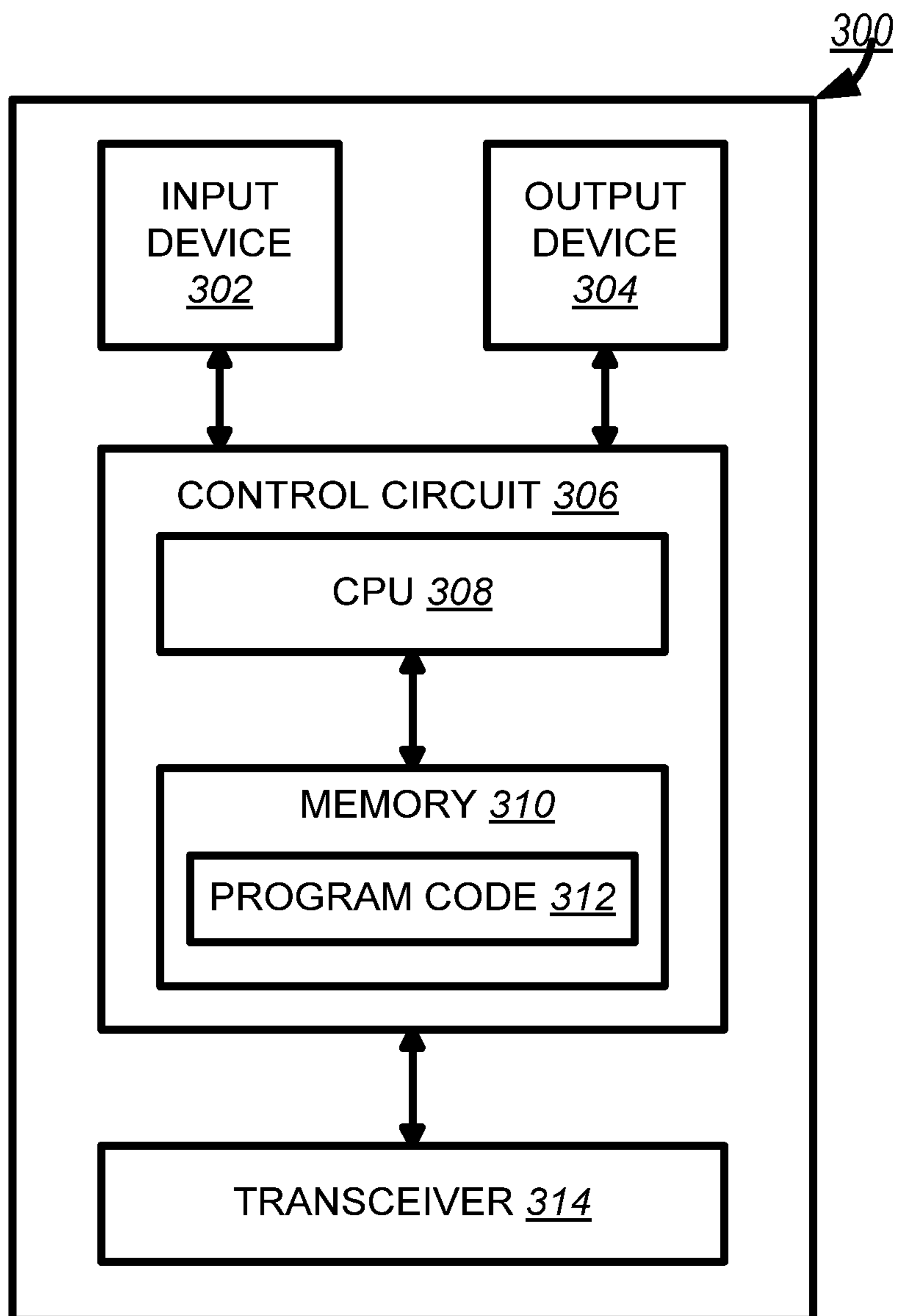


FIG. 3

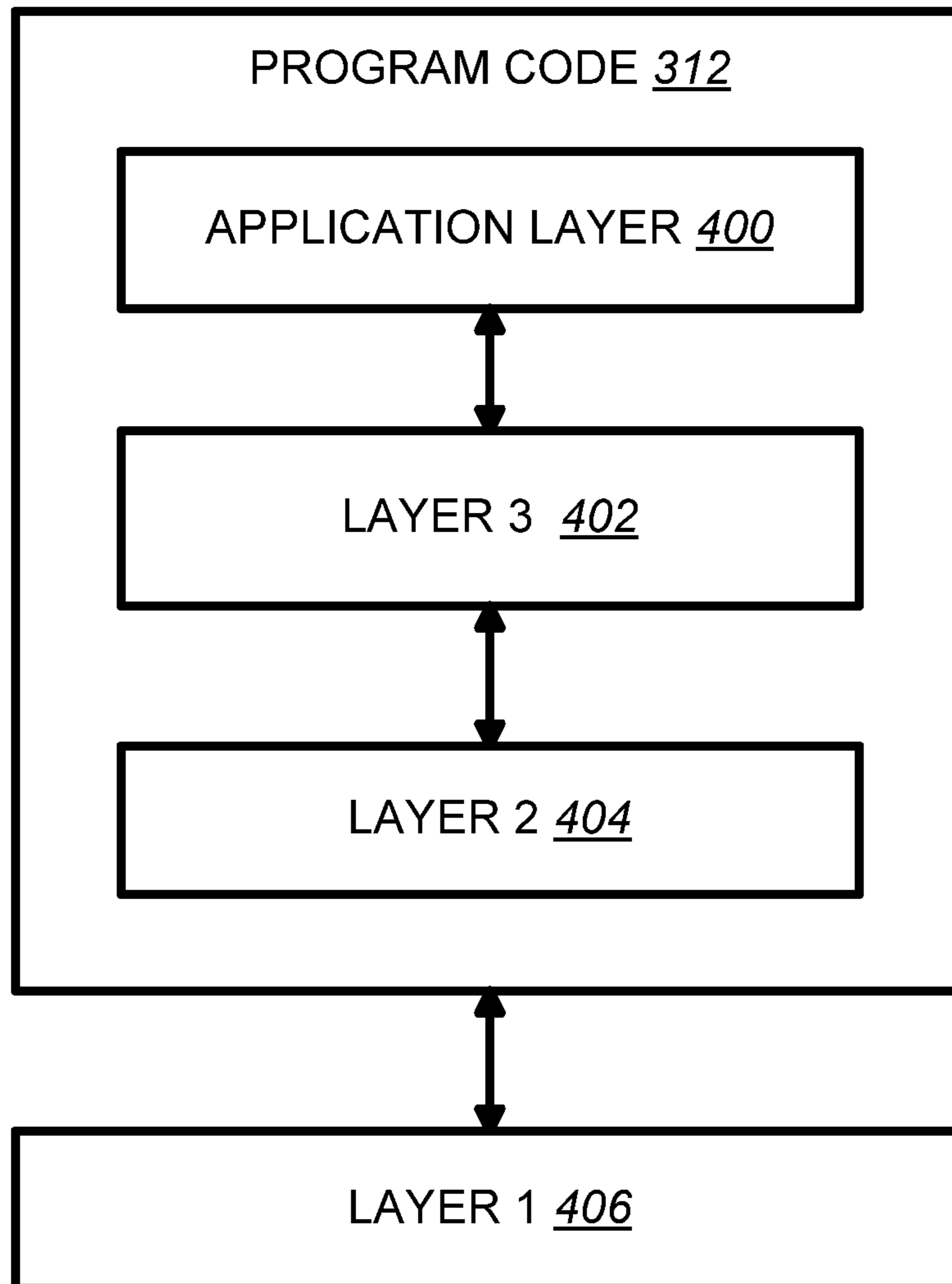


FIG. 4

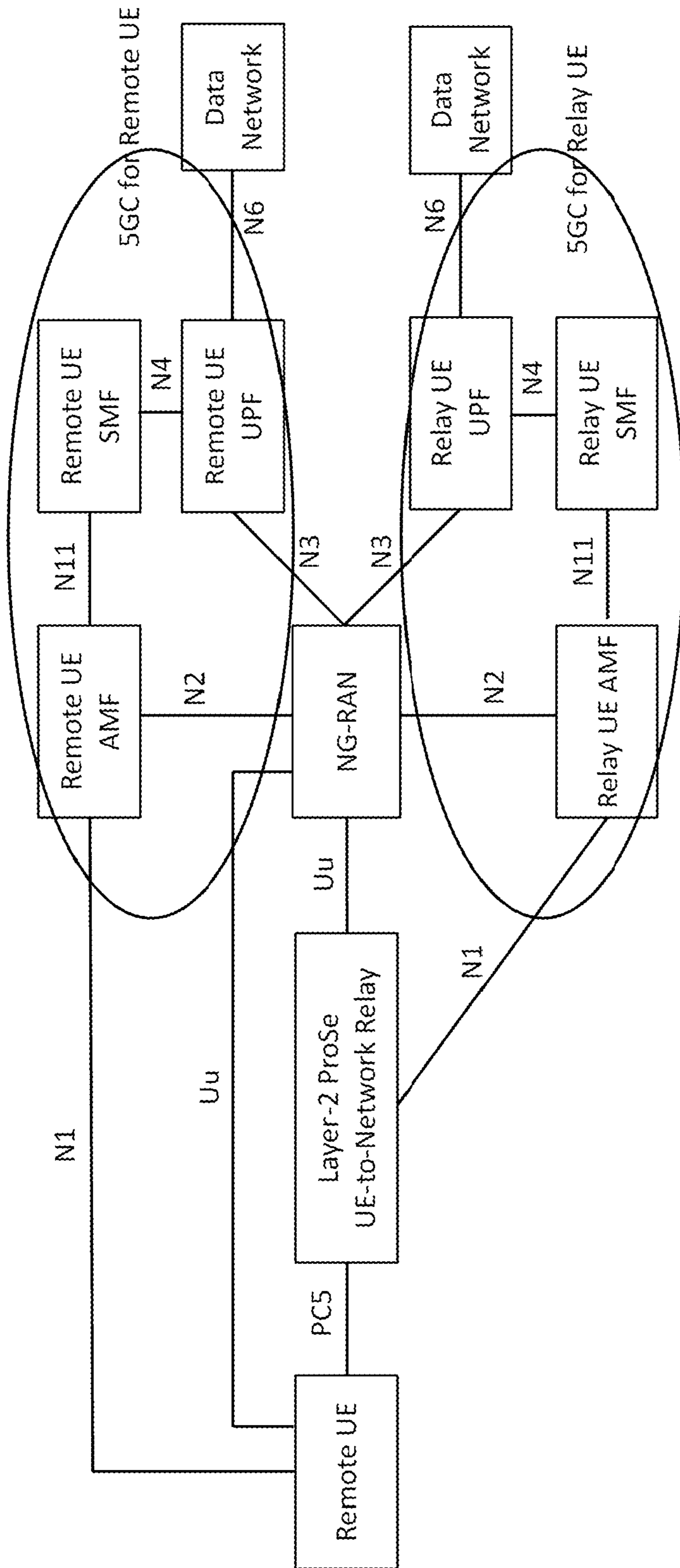


FIG. 5 (PRIOR ART)

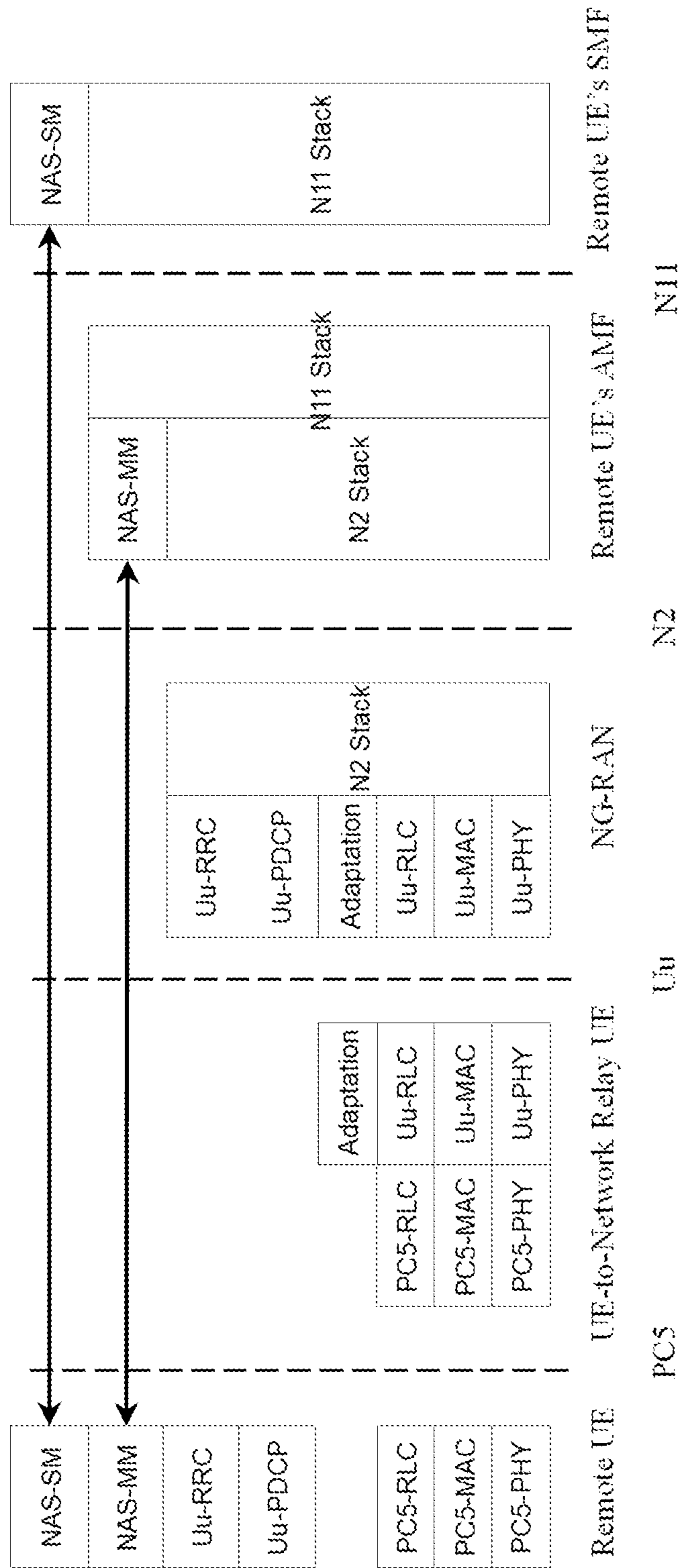


FIG. 6 (PRIOR ART)

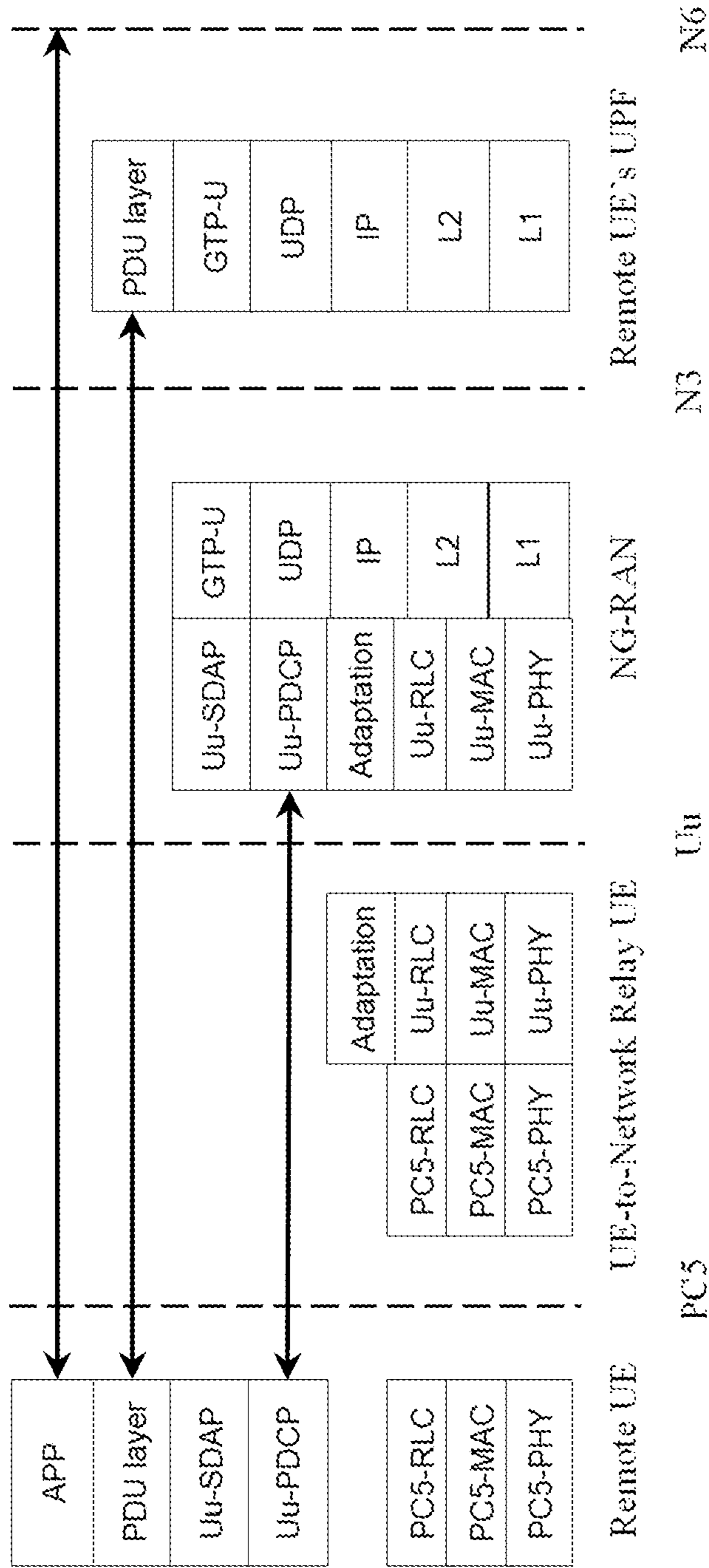


FIG. 7 (PRIOR ART)

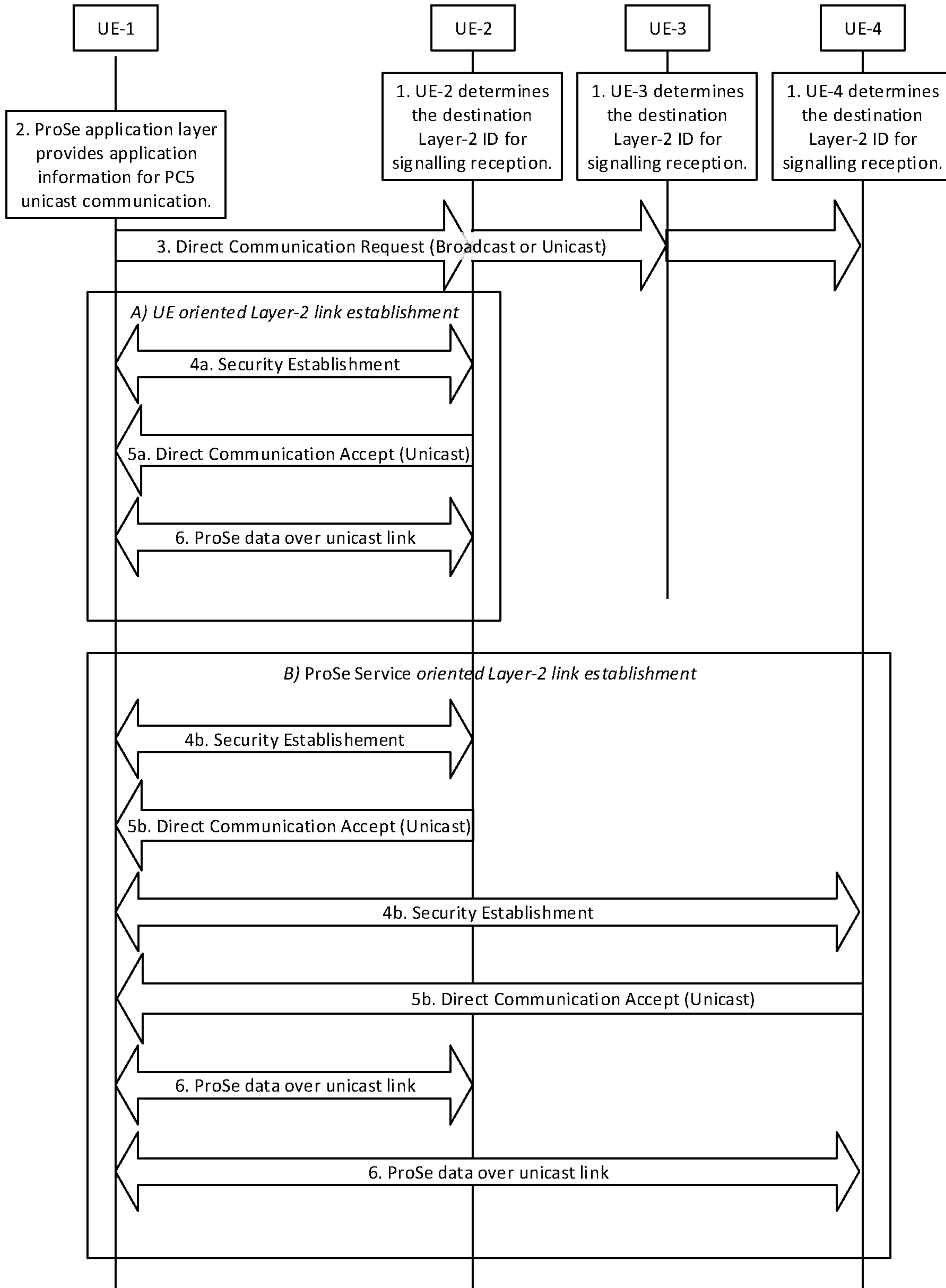


FIG. 8 (PRIOR ART)

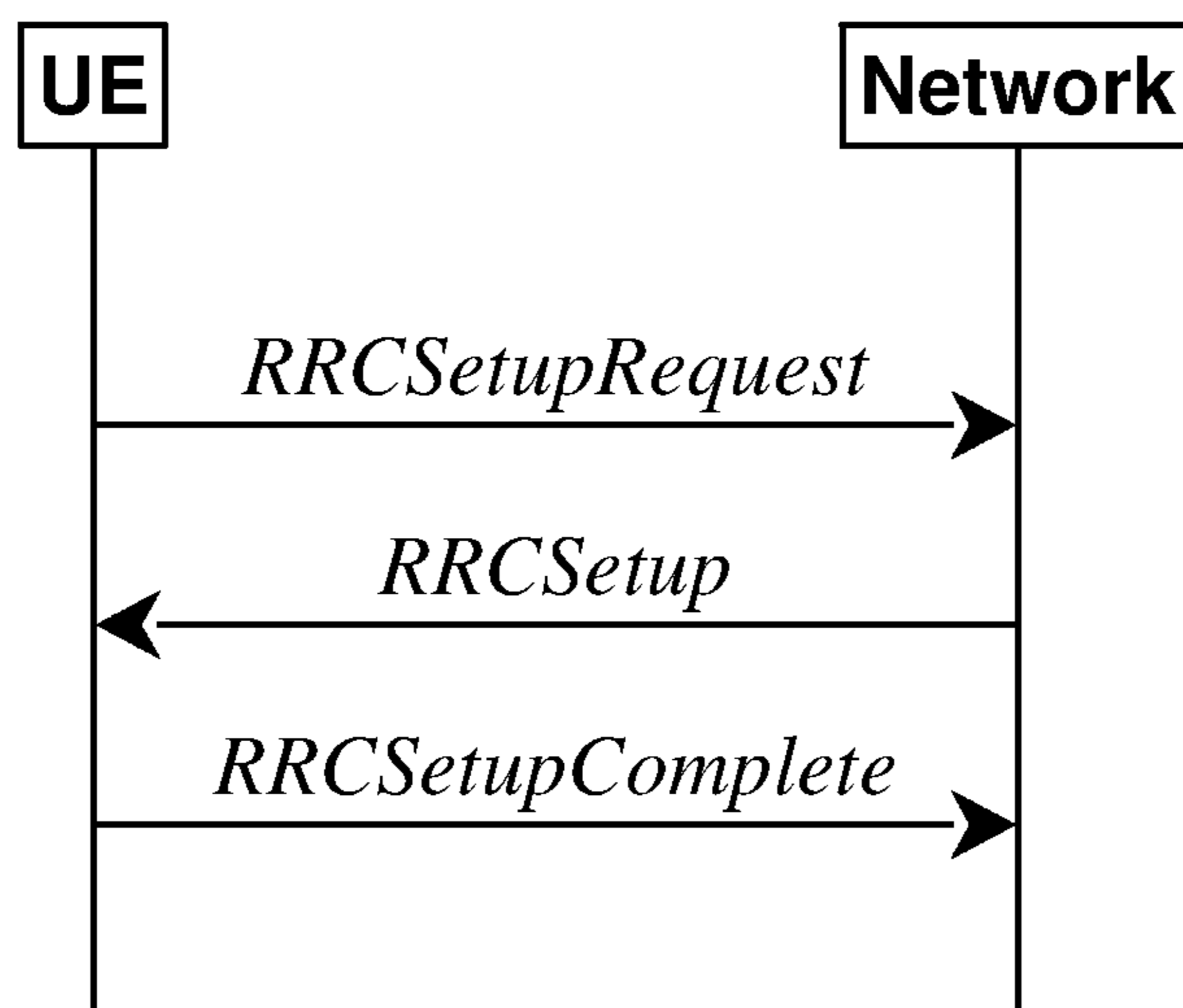


FIG. 9 (PRIOR ART)

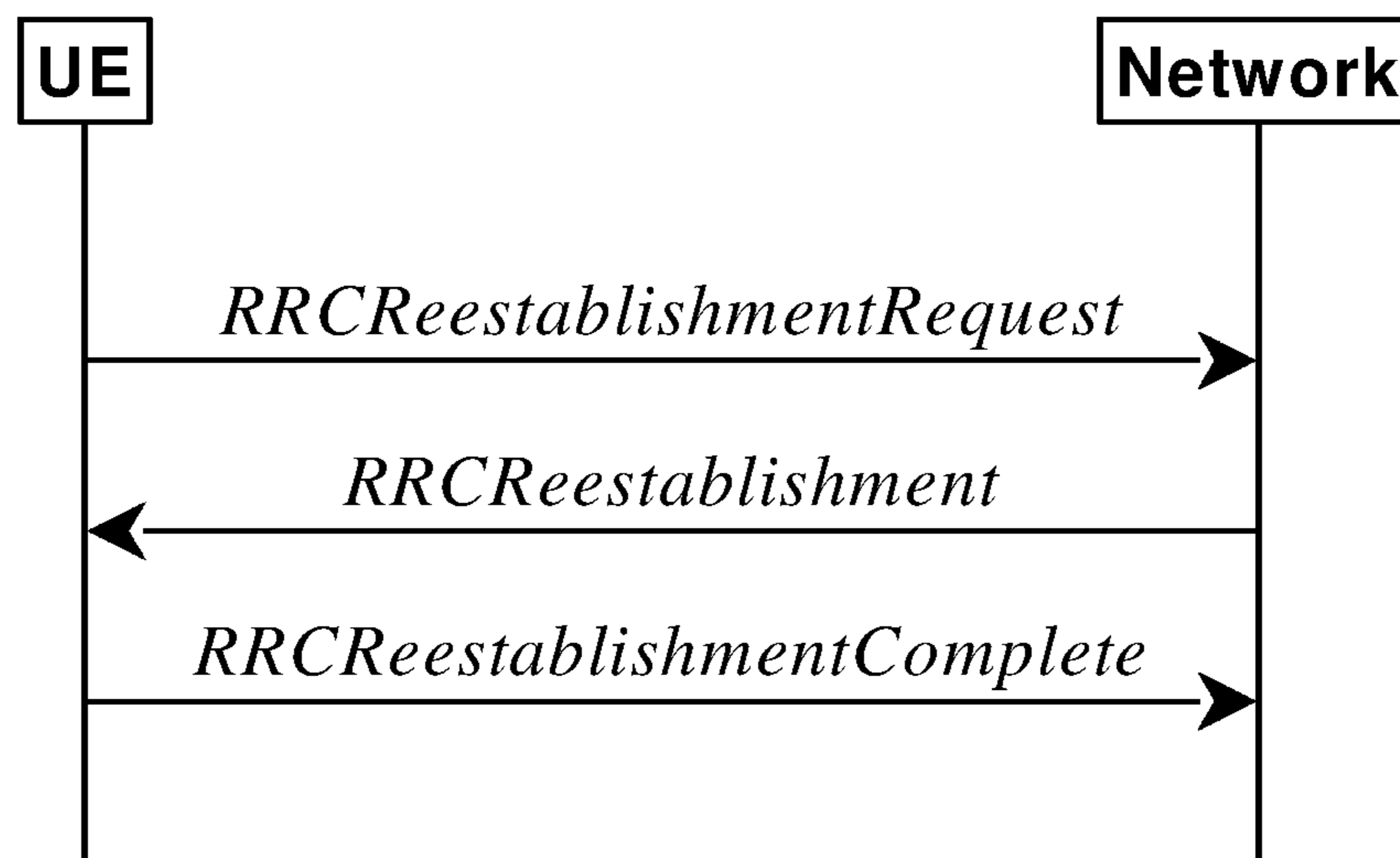


FIG. 10 (PRIOR ART)

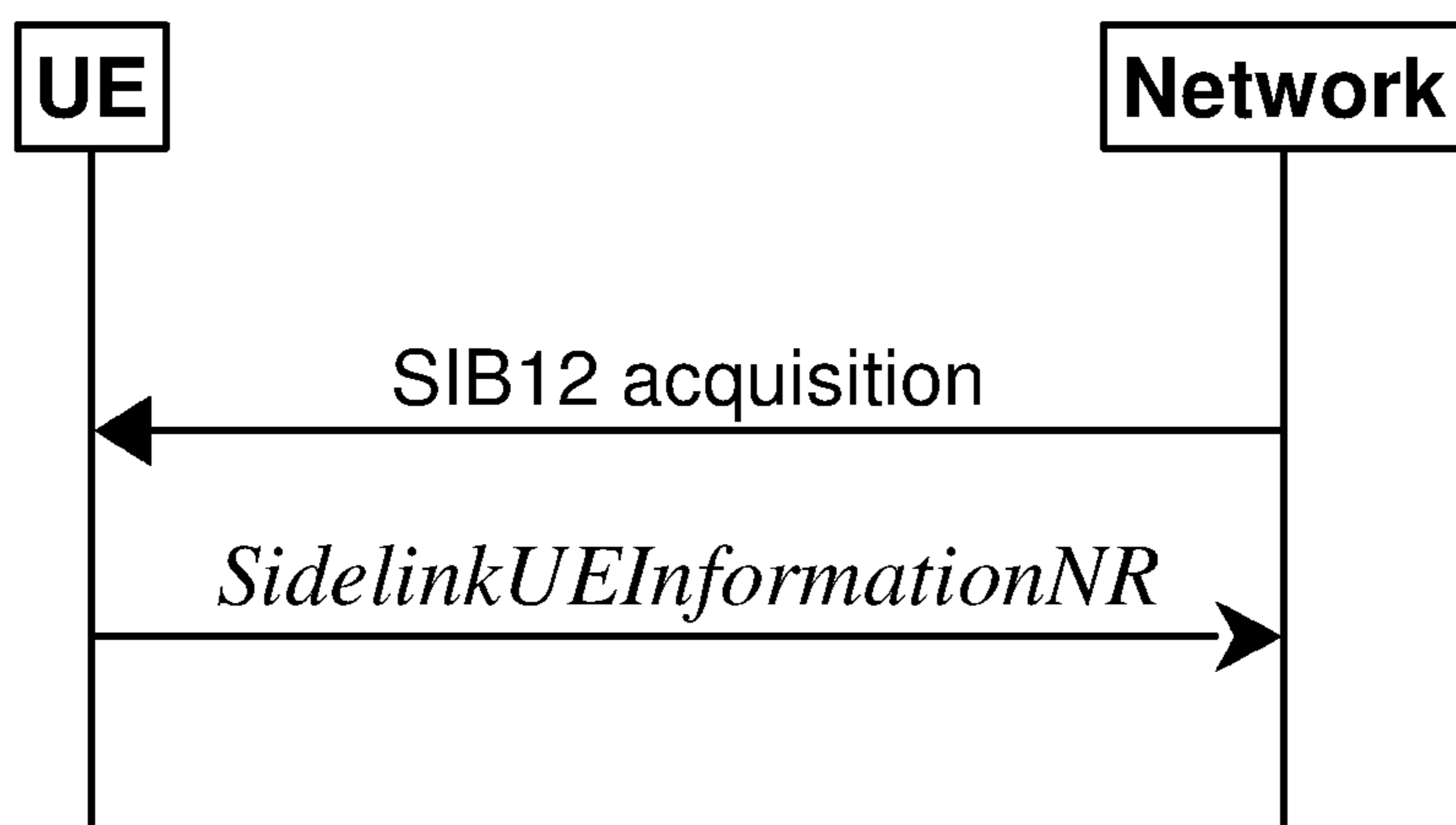


FIG. 11 (PRIOR ART)

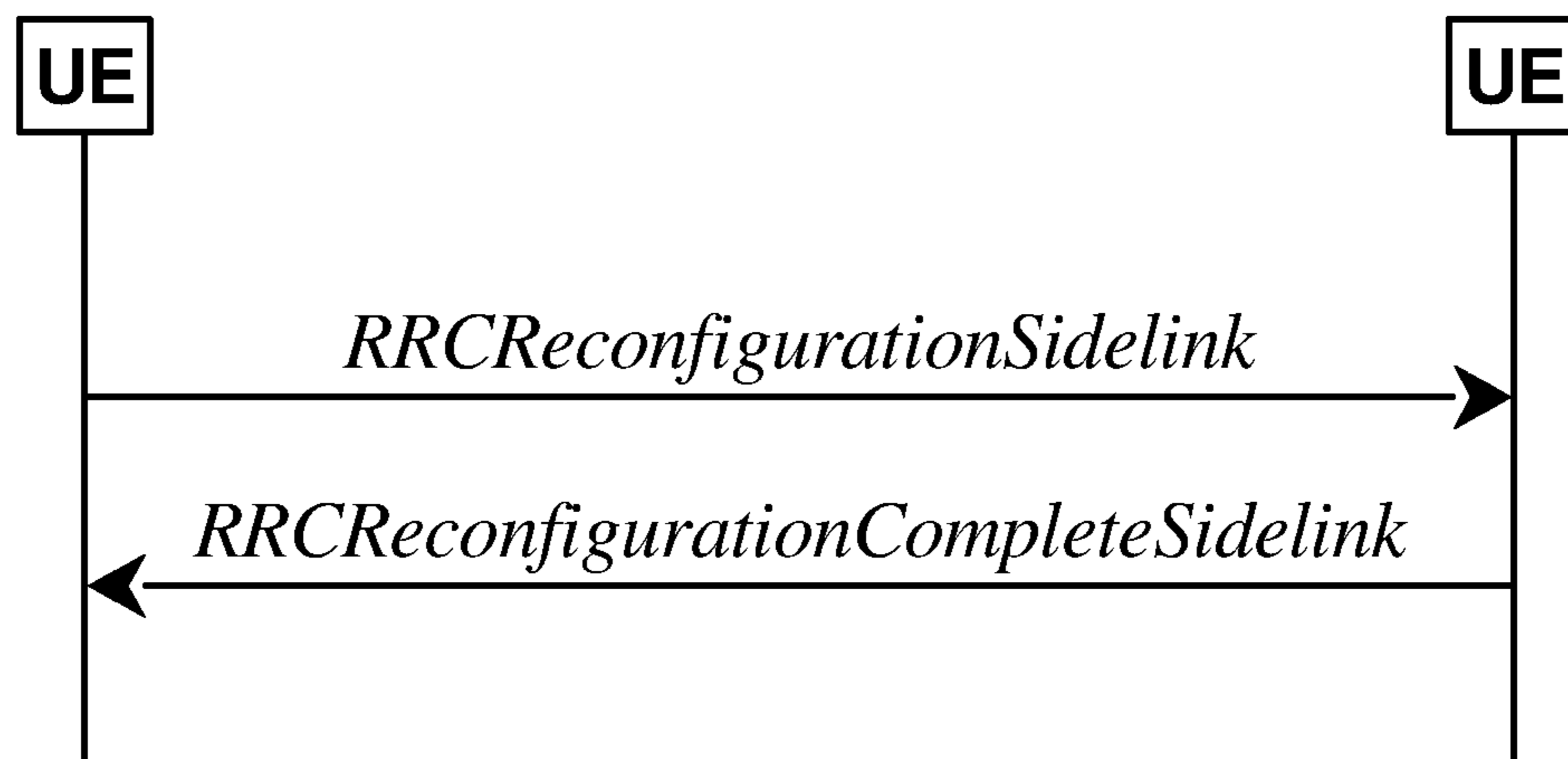


FIG. 12 (PRIOR ART)

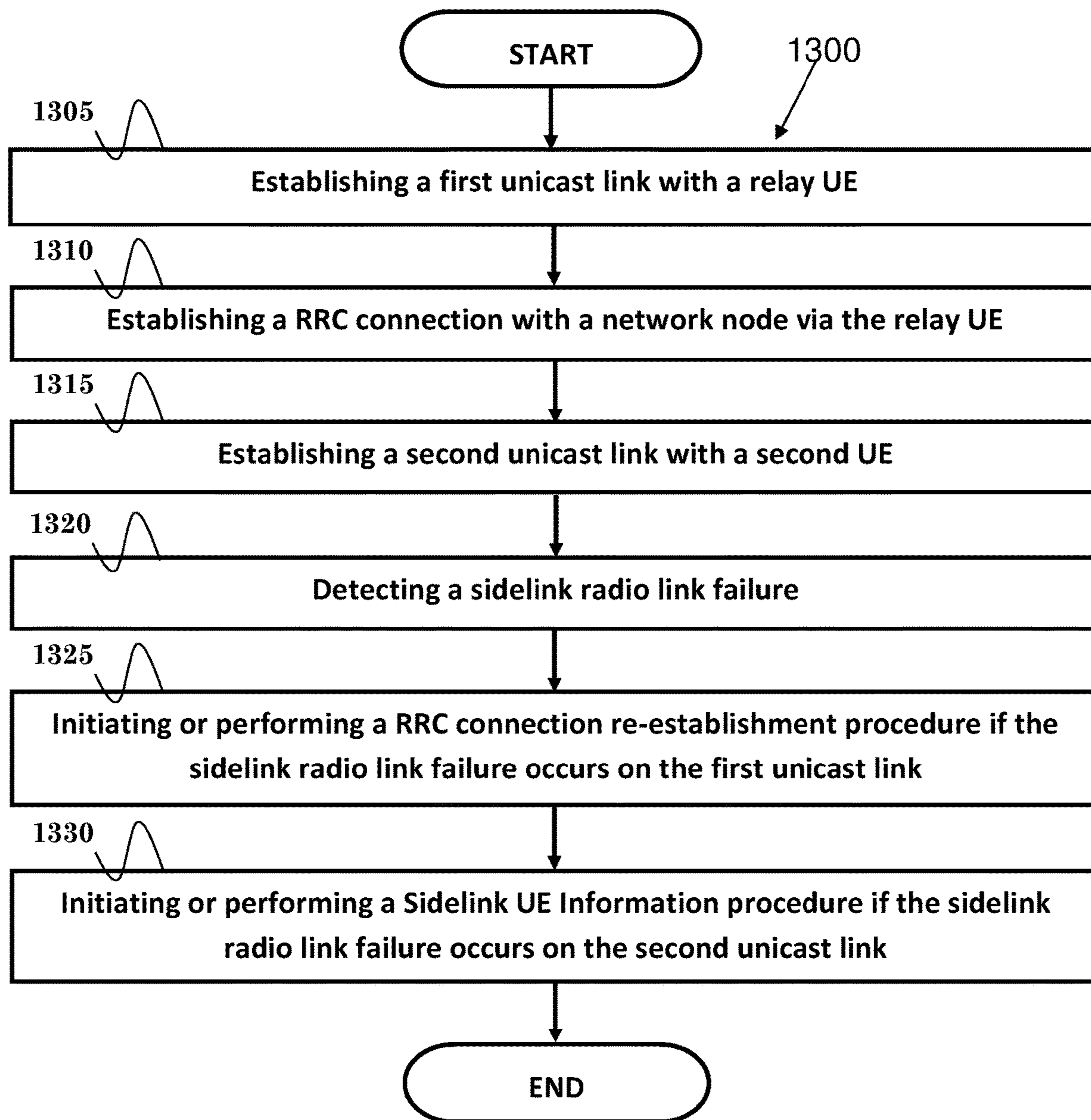


FIG. 13

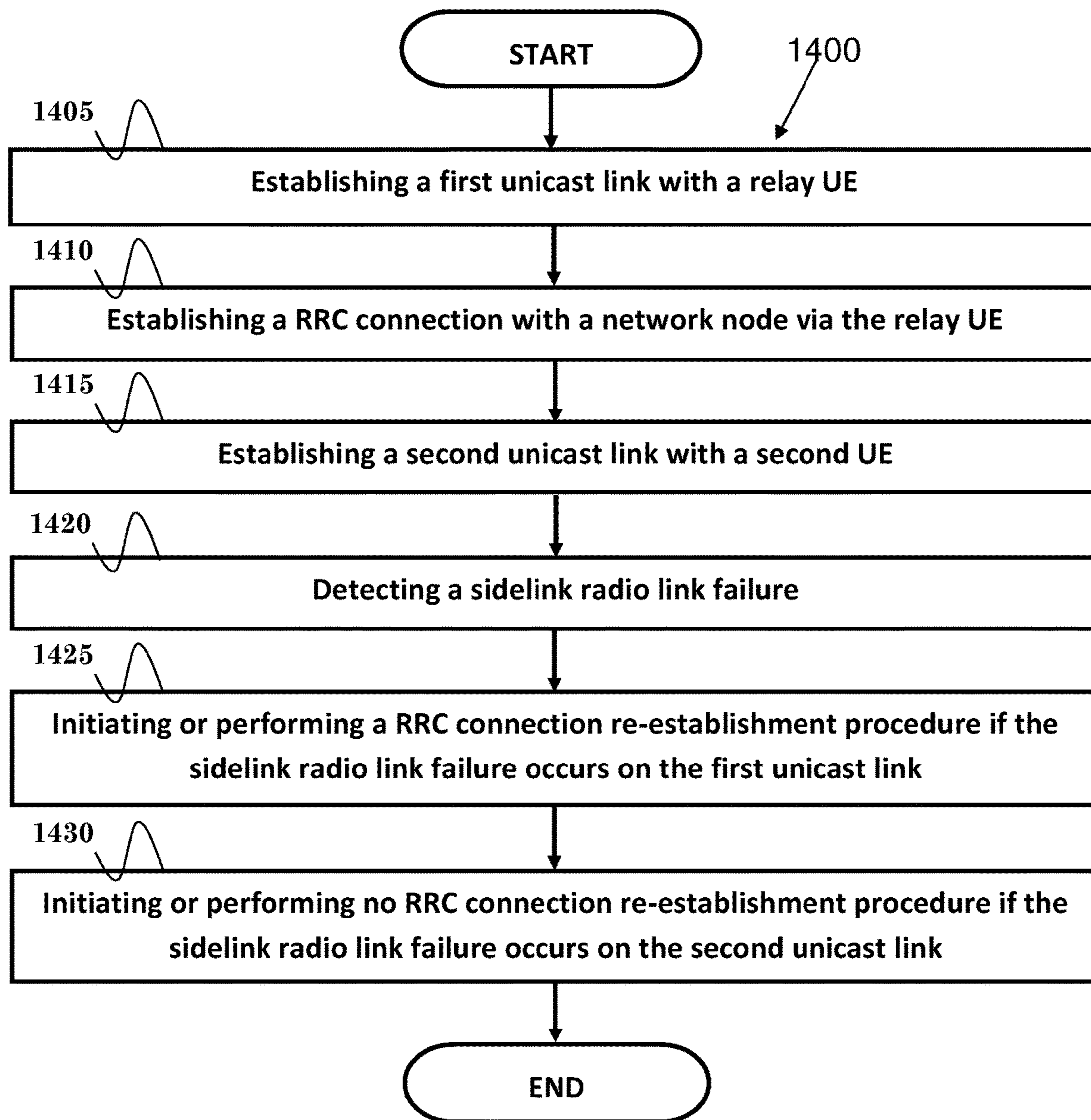


FIG. 14

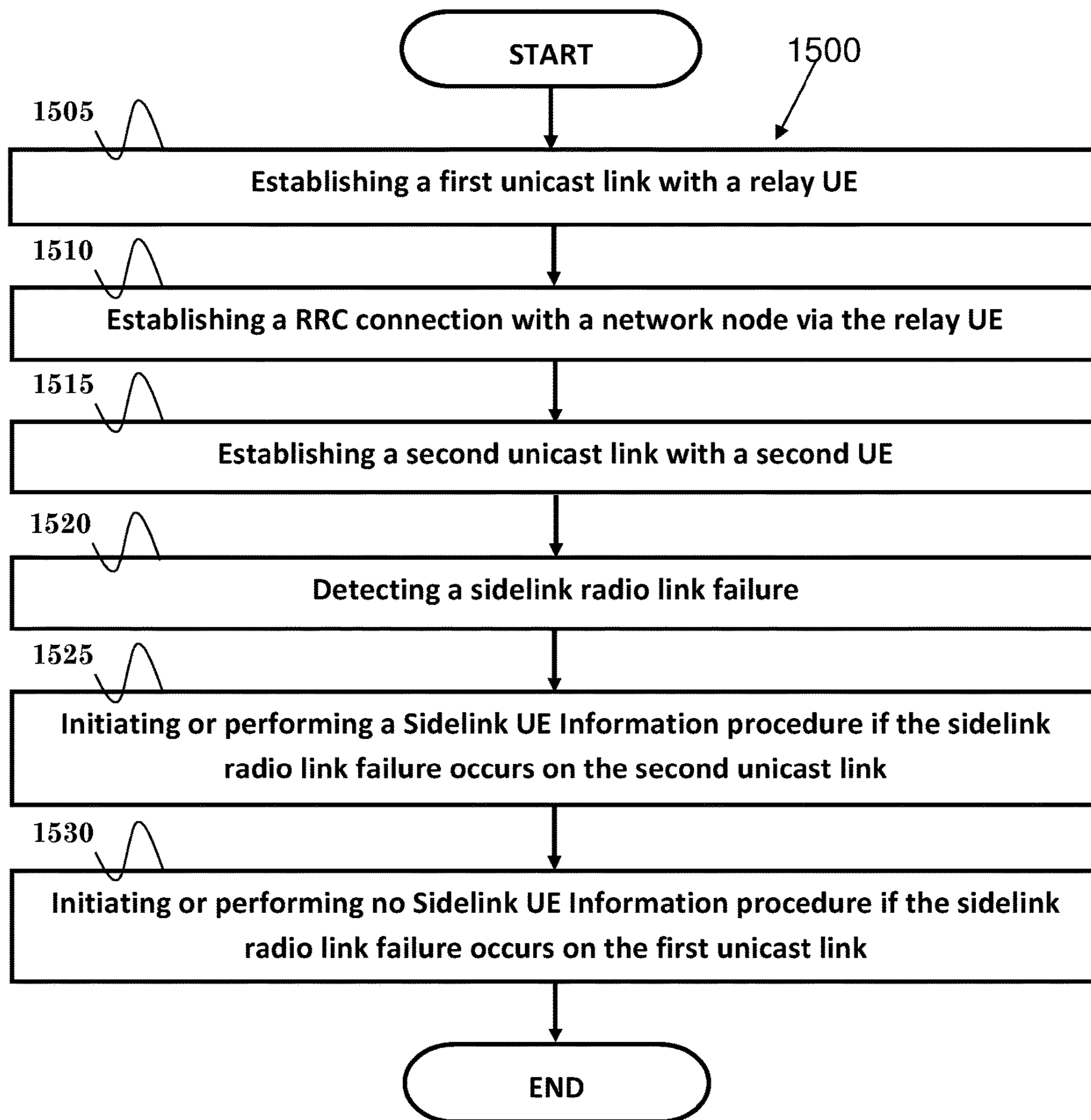


FIG. 15

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**METHOD AND APPARATUS FOR
SUPPORTING UE-TO-NETWORK RELAY
COMMUNICATION IN A WIRELESS
COMMUNICATION SYSTEM**

CROSS-REFERENCE TO RELATED
APPLICATIONS

The present Application claims the benefit of U.S. Provisional Patent Application Ser. No. 63/272,078 filed on Oct. 26, 2021, the entire disclosure of which is incorporated herein in its entirety by reference.

FIELD

This disclosure generally relates to wireless communication networks, and more particularly, to a method and apparatus for supporting UE-to-network relay communication in a wireless communication system.

BACKGROUND

With the rapid rise in demand for communication of large amounts of data to and from mobile communication devices, traditional mobile voice communication networks are evolving into networks that communicate with Internet Protocol (IP) data packets. Such IP data packet communication can provide users of mobile communication devices with voice over IP, multimedia, multicast and on-demand communication services.

An exemplary network structure is an Evolved Universal Terrestrial Radio Access Network (E-UTRAN). The E-UTRAN system can provide high data throughput in order to realize the above-noted voice over IP and multimedia services. A new radio technology for the next generation (e.g., 5G) is currently being discussed by the 3GPP standards organization. Accordingly, changes to the current body of 3GPP standard are currently being submitted and considered to evolve and finalize the 3GPP standard.

SUMMARY

A method and device are disclosed from the perspective of a remote UE. In one embodiment, the method includes the remote UE establishing a first unicast link with a relay UE. The method also includes the remote UE establishing a Radio Resource Control (RRC) connection with a network node via the relay UE. The method further includes the remote UE establishing a second unicast link with a second UE. In addition, the method includes the remote UE detecting a sidelink radio link failure. Furthermore, the method includes the remote UE initiating or performing a RRC connection re-establishment procedure if the sidelink radio link failure occurs on the first unicast link. The method also includes the remote UE initiating or performing a Sidelink UE Information procedure if the sidelink radio link failure occurs on the second unicast link.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a diagram of a wireless communication system according to one exemplary embodiment.

FIG. 2 is a block diagram of a transmitter system (also known as access network) and a receiver system (also known as user equipment or UE) according to one exemplary embodiment.

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FIG. 3 is a functional block diagram of a communication system according to one exemplary embodiment.

FIG. 4 is a functional block diagram of the program code of FIG. 3 according to one exemplary embodiment.

FIG. 5 is a reproduction of FIG. 4.2.7.2-1 of 3GPP TS 23.304 V17.0.0.

FIG. 6 is a reproduction of FIG. 6.1.1.7.2-1 of 3GPP TS 23.304 V17.0.0.

FIG. 7 is a reproduction of FIG. 6.1.2.3.2-1 of 3GPP TS 23.304 V17.0.0.

FIG. 8 is a reproduction of FIG. 6.4.3.1-1 of 3GPP TS 23.304 V17.0.0.

FIG. 9 is a reproduction of FIG. 5.3.3.1-1 of 3GPP TS 38.331 V16.6.0.

FIG. 10 is a reproduction of FIG. 5.3.7.1-1 of 3GPP TS 38.331 V16.6.0.

FIG. 11 is a reproduction of FIG. 5.8.3.1-1 of 3GPP TS 38.331 V16.6.0.

FIG. 12 is a reproduction of FIG. 5.8.9.1.1-1 of 3GPP TS 38.331 V16.6.0.

FIG. 13 is a flow chart according to one exemplary embodiment.

FIG. 14 is a flow chart according to one exemplary embodiment.

FIG. 15 is a flow chart according to one exemplary embodiment.

DETAILED DESCRIPTION

The exemplary wireless communication systems and devices described below employ a wireless communication system, supporting a broadcast service. Wireless communication systems are widely deployed to provide various types of communication such as voice, data, and so on. These systems may be based on code division multiple access (CDMA), time division multiple access (TDMA), orthogonal frequency division multiple access (OFDMA), 3GPP LTE (Long Term Evolution) wireless access, 3GPP LTE-A or LTE-Advanced (Long Term Evolution Advanced), 3GPP2 UMB (Ultra Mobile Broadband), WiMax, 3GPP NR (New Radio), or some other modulation techniques.

In particular, the exemplary wireless communication systems and devices described below may be designed to support one or more standards such as the standard offered by a consortium named “3rd Generation Partnership Project” referred to herein as 3GPP, including: TS 23.304 V17.0.0, “Proximity based Services (ProSe) in the 5G System (5GS) (Release 17)”; TS 38.331 v16.6.0, “NR; Radio Resource Control (RRC) protocol specification (Release 16)”; and 3GPP email discussion [Post115-e][603] [Relay] Relaying CR to 38.331 (Huawei), “Draft_38331 Running CR for SL relay_v14_rapp.docx”. The standards and documents listed above are hereby expressly incorporated by reference in their entirety.

FIG. 1 shows a multiple access wireless communication system according to one embodiment of the invention. An access network 100 (AN) includes multiple antenna groups, one including 104 and 106, another including 108 and 110, and an additional including 112 and 114. In FIG. 1, only two antennas are shown for each antenna group, however, more or fewer antennas may be utilized for each antenna group. Access terminal 116 (AT) is in communication with antennas 112 and 114, where antennas 112 and 114 transmit information to access terminal 116 over forward link 120 and receive information from access terminal 116 over reverse link 118. Access terminal (AT) 122 is in communication with antennas 106 and 108, where antennas 106 and

108 transmit information to access terminal (AT) **122** over forward link **126** and receive information from access terminal (AT) **122** over reverse link **124**. In a FDD system, communication links **118**, **120**, **124** and **126** may use different frequency for communication. For example, forward link **120** may use a different frequency than that used by reverse link **118**.

Each group of antennas and/or the area in which they are designed to communicate is often referred to as a sector of the access network. In the embodiment, antenna groups each are designed to communicate to access terminals in a sector of the areas covered by access network **100**.

In communication over forward links **120** and **126**, the transmitting antennas of access network **100** may utilize beamforming in order to improve the signal-to-noise ratio of forward links for the different access terminals **116** and **122**. Also, an access network using beamforming to transmit to access terminals scattered randomly through its coverage causes less interference to access terminals in neighboring cells than an access network transmitting through a single antenna to all its access terminals.

An access network (AN) may be a fixed station or base station used for communicating with the terminals and may also be referred to as an access point, a Node B, a base station, an enhanced base station, an evolved Node B (eNB), a network node, a network, or some other terminology. An access terminal (AT) may also be called user equipment (UE), a wireless communication device, terminal, access terminal or some other terminology.

FIG. **2** is a simplified block diagram of an embodiment of a transmitter system **210** (also known as the access network) and a receiver system **250** (also known as access terminal (AT) or user equipment (UE)) in a MIMO system **200**. At the transmitter system **210**, traffic data for a number of data streams is provided from a data source **212** to a transmit (TX) data processor **214**.

In one embodiment, each data stream is transmitted over a respective transmit antenna. TX data processor **214** formats, codes, and interleaves the traffic data for each data stream based on a particular coding scheme selected for that data stream to provide coded data.

The coded data for each data stream may be multiplexed with pilot data using OFDM techniques. The pilot data is typically a known data pattern that is processed in a known manner and may be used at the receiver system to estimate the channel response. The multiplexed pilot and coded data for each data stream is then modulated (i.e., symbol mapped) based on a particular modulation scheme (e.g., BPSK, QPSK, M-PSK, or M-QAM) selected for that data stream to provide modulation symbols. The data rate, coding, and modulation for each data stream may be determined by instructions performed by processor **230**.

The modulation symbols for all data streams are then provided to a TX MIMO processor **220**, which may further process the modulation symbols (e.g., for OFDM). TX MIMO processor **220** then provides N_T modulation symbol streams to N_T transmitters (TMTR) **222a** through **222t**. In certain embodiments, TX MIMO processor **220** applies beamforming weights to the symbols of the data streams and to the antenna from which the symbol is being transmitted.

Each transmitter **222** receives and processes a respective symbol stream to provide one or more analog signals, and further conditions (e.g., amplifies, filters, and upconverts) the analog signals to provide a modulated signal suitable for transmission over the MIMO channel. N_T modulated signals from transmitters **222a** through **222t** are then transmitted from N_T antennas **224a** through **224t**, respectively.

At receiver system **250**, the transmitted modulated signals are received by N_R antennas **252a** through **252r** and the received signal from each antenna **252** is provided to a respective receiver (RCVR) **254a** through **254r**. Each receiver **254** conditions (e.g., filters, amplifies, and down-converts) a respective received signal, digitizes the conditioned signal to provide samples, and further processes the samples to provide a corresponding “received” symbol stream.

An RX data processor **260** then receives and processes the N_R received symbol streams from N_R receivers **254** based on a particular receiver processing technique to provide N_T “detected” symbol streams. The RX data processor **260** then demodulates, deinterleaves, and decodes each detected symbol stream to recover the traffic data for the data stream. The processing by RX data processor **260** is complementary to that performed by TX MIMO processor **220** and TX data processor **214** at transmitter system **210**.

A processor **270** periodically determines which pre-coding matrix to use (discussed below). Processor **270** formulates a reverse link message comprising a matrix index portion and a rank value portion.

The reverse link message may comprise various types of information regarding the communication link and/or the received data stream. The reverse link message is then processed by a TX data processor **238**, which also receives traffic data for a number of data streams from a data source **236**, modulated by a modulator **280**, conditioned by transmitters **254a** through **254r**, and transmitted back to transmitter system **210**.

At transmitter system **210**, the modulated signals from receiver system **250** are received by antennas **224**, conditioned by receivers **222**, demodulated by a demodulator **240**, and processed by a RX data processor **242** to extract the reverse link message transmitted by the receiver system **250**. Processor **230** then determines which pre-coding matrix to use for determining the beamforming weights then processes the extracted message.

Turning to FIG. **3**, this figure shows an alternative simplified functional block diagram of a communication device according to one embodiment of the invention. As shown in FIG. **3**, the communication device **300** in a wireless communication system can be utilized for realizing the UEs (or ATs) **116** and **122** in FIG. **1** or the base station (or AN) **100** in FIG. **1**, and the wireless communications system is preferably the NR system. The communication device **300** may include an input device **302**, an output device **304**, a control circuit **306**, a central processing unit (CPU) **308**, a memory **310**, a program code **312**, and a transceiver **314**. The control circuit **306** executes the program code **312** in the memory **310** through the CPU **308**, thereby controlling an operation of the communications device **300**. The communications device **300** can receive signals input by a user through the input device **302**, such as a keyboard or keypad, and can output images and sounds through the output device **304**, such as a monitor or speakers. The transceiver **314** is used to receive and transmit wireless signals, delivering received signals to the control circuit **306**, and outputting signals generated by the control circuit **306** wirelessly. The communication device **300** in a wireless communication system can also be utilized for realizing the AN **100** in FIG. **1**.

FIG. **4** is a simplified block diagram of the program code **312** shown in FIG. **3** in accordance with one embodiment of the invention. In this embodiment, the program code **312** includes an application layer **400**, a Layer 3 portion **402**, and a Layer 2 portion **404**, and is coupled to a Layer 1 portion

406. The Layer 3 portion **402** generally performs radio resource control. The Layer 2 portion **404** generally performs link control. The Layer 1 portion **406** generally performs physical connections.

3GPP TS 23.304 introduced the following:

4.3.9 5G ProSe UE-to-Network Relay

4.3.9.1 General

Both 5G ProSe Layer-2 and Layer-3 UE-to-Network Relay entity provides the relaying functionality to support connectivity to the network for 5G ProSe Remote UEs. It can be used for both public safety services and commercial services (e.g. interactive service). Both 5G ProSe Layer-2 and Layer-3 UE-to-Network Relay supports the following functions to enable connectivity to the network:

5G ProSe UE-to-Network Relay Discovery service as defined in clause 6.3.2.3, to allow discovery by the 5G ProSe Remote UE;

access the 5GS as a UE as defined in TS 23.501 [4] with the enhancements as specified in clauses 6.2 and 6.6; relays unicast traffic (uplink and downlink) between the 5G ProSe Remote UE and the network, supporting IP, Ethernet or Unstructured traffic type.

NOTE: Relaying MBS traffic to a 5G ProSe Remote UE by a 5G ProSe UE-to-Network Relay is not supported in this release of the specification.

[. . .]

4.2.7.2 5G ProSe Layer-2 UE-to-Network Relay Reference Architecture

FIG. 4.2.7.2-1 show the 5G ProSe Layer-2 UE-to-Network Relay reference architecture. The 5G ProSe Layer-2 Remote UE and 5G ProSe Layer-2 UE-to-Network Relay may be served by the same or different PLMNs. If the serving PLMNs of the 5G ProSe Layer-2 Remote UE and the 5G ProSe Layer-2 UE-to-Network Relay are different then NG-RAN is shared by the serving PLMNs, see the 5G MOCN architecture in clause 5.18 of TS 23.501 [4].

FIG. 4.2.7.2-1 of 3GPP TS 23.304 V17.0.0, Entitled “5G ProSe Layer-2 UE-to-Network Relay Reference Architecture”, is Reproduced as FIG. 5

NOTE 1: Uu between the 5G ProSe Layer-2 Remote UE and NG-RAN consists of RRC, SDAP and PDCP.

NOTE 2: The 5G ProSe Layer-2 Remote UE and 5G ProSe Layer-2 UE-to-Network Relay are served by the same NG-RAN. The Core Network entities (e.g., AMF, SMF, UPF) serving the 5G ProSe Layer-2 Remote UE and the 5G ProSe Layer-2 UE-to-Network Relay can be the same or different.

[. . .]

6.1.1.7.2 5G ProSe Layer-2 UE-to-Network Relay The UE-UE protocol stacks for discovery and PC5 signalling defined in clause 6.1.1.2 apply to 5G ProSe Remote UE and 5G ProSe Layer-2 UE-to-Network Relay.

FIG. 6.1.1.7.2-1 illustrates the protocol stack of the NAS connection for the 5G ProSe Layer-2 Remote UE for NAS-MM and NAS-SM. The NAS messages are transparently transferred between the 5G ProSe Layer-2 Remote UE and NG-RAN over the 5G ProSe Layer-2 UE-to-Network Relay using:

PDCP end-to-end connection between the 5G ProSe Layer-2 Remote UE and NG-RAN, where the role of the 5G ProSe Layer-2 UE-to-Network Relay is to relay the PDUs over the signalling radio bear without any modifications and using the functionality of the adaptation layer as specified in TS 38.351 [28].

Connection between NG-RAN and AMF over N2.

Connection between AMF and SMF over N11.

Editor’s note: Whether the adaptation layer is supported over PC5 will be determined by RAN WG2.

FIG. 6.1.1.7.2-1 of 3GPP TS 23.304 V17.0.0, Entitled “End-to-End Control Plane for a Remote UE Using Layer-2 UE-to-Network Relay”, is Reproduced as FIG. 6

The control plane protocol stack used by the 5G ProSe Layer-2 UE-to-Network Relay is defined in clause 8.2.2 of TS 23.501 [4].

[. . .]

6.1.2.3.2 5G ProSe Layer-2 UE-to-Network Relay FIG. 6.1.2.2.2-1 illustrates the protocol stack for the user plane transport, related to a PDU Session, including a 5G ProSe Layer 2 UE-to-Network Relay. The PDU layer corresponds to the PDU carried between the 5G ProSe Layer-2 Remote UE and the Data Network (DN) over the PDU session. The SDAP and PDCP protocols are specified in TS 38.300 [12]. PDCP end-to-end connection is between the 5G ProSe Layer-2 Remote UE and NG-RAN. The functionality of the adaptation layer is specified in TS 38.351 [28].

Editor’s note: Whether the adaptation layer is supported over PC5 will be determined by RAN WG2.

FIG. 6.1.2.3.2-1 of 3GPP TS 23.304 V17.0.0, Entitled “End-to-End User Plane Stack for a 5G ProSe Remote UE Using 5G ProSe Layer-2 UE-to-Network Relay”, is Reproduced as FIG. 7

[. . .]

6.4 5G ProSe Direct Communication

[. . .]

6.4.3 Unicast Mode 5G ProSe Direct Communication 6.4.3.1 Layer-2 Link Establishment Over PC5 Reference Point

To perform unicast mode of ProSe Direct communication over PC5 reference point, the UE is configured with the related information as described in clause 5.1.3.

FIG. 6.4.3.1-1 shows the layer-2 link establishment procedure for the unicast mode of ProSe Direct communication over PC5 reference point.

FIG. 6.4.3.1-1 of 3GPP TS 23.304 V17.0.0, Entitled “Layer-2 Link Establishment Procedure”, is Reproduced as FIG. 8

1. The UE(s) determine the destination Layer-2 ID for signalling reception for PC5 unicast link establishment as specified in clause 5.8.2.4.

2. The ProSe application layer in UE-1 provides application information for PC5 unicast communication. The application information includes the ProSe Service Info, UE’s Application Layer ID. The target UE’s Application Layer ID may be included in the application information.

The ProSe application layer in UE-1 may provide ProSe Application Requirements for this unicast communication. UE-1 determines the PC5 QoS parameters and PFI as specified in clause 5.6.1.

If UE-1 decides to reuse the existing PC5 unicast link as specified in clause 5.3.4, the UE triggers the Layer-2 link modification procedure as specified in clause 6.4.3.4.

3. UE-1 sends a Direct Communication Request message to initiate the unicast layer-2 link establishment procedure. The Direct Communication Request message includes:
- Source User Info: the initiating UE's Application Layer ID (i.e. UE-Vs Application Layer ID).
 If the ProSe application layer provided the target UE's Application Layer ID in step 2, the following information is included:
 Target User Info: the target UE's Application Layer ID (i.e. UE-2's Application Layer ID)
 ProSe Service Info: the information about the ProSe identifier(s) requesting Layer-2 link establishment.
 Security Information: the information for the establishment of security.
- NOTE 1: The Security Information and the necessary protection of the Source User Info and Target User Info are defined by SA WG3.
- The source Layer-2 ID and destination Layer-2 ID used to send the Direct Communication Request message are determined as specified in clauses 5.8.2.1 and 5.8.2.4. The destination Layer-2 ID may be broadcast or unicast Layer-2 ID. When unicast Layer-2 ID is used, the Target User Info shall be included in the Direct Communication Request message.
- UE-1 sends the Direct Communication Request message via PC5 broadcast or unicast using the source Layer-2 ID and the destination Layer-2 ID.
4. Security with UE-1 is established as below:
- 4a. If the Target User Info is included in the Direct Communication Request message, the target UE, i.e. UE-2, responds by establishing the security with UE-1.
- 4b. If the Target User Info is not included in the Direct Communication Request message, the UEs that are interested in using the announced ProSe Service(s) over a PC5 unicast link with UE-1 responds by establishing the security with UE-1.
- NOTE 2: The signalling for the Security Procedure is defined by SA WG3. When the security protection is enabled, UE-1 sends the following information to the target UE:
- If IP communication is used:
 IP Address Configuration: For IP communication, IP address configuration is required for this link and indicates one of the following values:
 "DHCPv4 server" if only IPv4 address allocation mechanism is supported by the initiating UE, i.e., acting as a DHCPv4 server; or
 "IPv6 Router" if only IPv6 address allocation mechanism is supported by the initiating UE, i.e., acting as an IPv6 Router; or
 "DHCPv4 server & IPv6 Router" if both IPv4 and IPv6 address allocation mechanism are supported by the initiating UE; or
 "address allocation not supported" if neither IPv4 nor IPv6 address allocation mechanism is supported by the initiating UE.
- Link-Local IPv6 Address: a link-local IPv6 address formed locally based on RFC 4862 [17] if UE-1 does not support the IPv6 IP address allocation mechanism, i.e. the IP Address Configuration indicates "address allocation not supported".
- QoS Info: the information about PC5 QoS Flow(s). For each PC5 QoS Flow, the PFI and the corresponding PC5 QoS parameters (i.e. PQI and conditionally

- other parameters such as MFBR/GFBR, etc.) and the associated ProSe identifier(s).
- The source Layer-2 ID used for the security establishment procedure is determined as specified in clauses 5.8.2.1 and 5.8.2.4. The destination Layer-2 ID is set to the source Layer-2 ID of the received Direct Communication Request message.
- Upon receiving the security establishment procedure messages, UE-1 obtains the peer UE's Layer-2 ID for future communication, for signalling and data traffic for this unicast link.
5. A Direct Communication Accept message is sent to UE-1 by the target UE(s) that has successfully established security with UE-1:
- 5a. (UE oriented Layer-2 link establishment) If the Target User Info is included in the Direct Communication Request message, the target UE, i.e. UE-2 responds with a Direct Communication Accept message if the Application Layer ID for UE-2 matches.
- 5b. (ProSe Service oriented Layer-2 link establishment) If the Target User Info is not included in the Direct Communication Request message, the UEs that are interested in using the announced ProSe Service(s) respond to the request by sending a Direct Communication Accept message (UE-2 and UE-4 in FIG. 6.3.3.1-1).
- The Direct Communication Accept message includes:
 Source User Info: Application Layer ID of the UE sending the Direct Communication Accept message.
 QoS Info: the information about PC5 QoS Flow(s). For each PC5 QoS Flow, the PFI and the corresponding PC5 QoS parameters requested by UE-1 (i.e. PQI and conditionally other parameters such as MFBR/GFBR, etc) and the associated ProSe identifiers(s).
- If IP communication is used:
 IP Address Configuration: For IP communication, IP address configuration is required for this link and indicates one of the following values:
 "DHCPv4 server" if only IPv4 address allocation mechanism is supported by the target UE, i.e., acting as a DHCPv4 server; or
 "IPv6 Router" if only IPv6 address allocation mechanism is supported by the target UE, i.e., acting as an IPv6 Router; or
 "DHCPv4 server & IPv6 Router" if both IPv4 and IPv6 address allocation mechanism are supported by the target UE; or
 "address allocation not supported" if neither IPv4 nor IPv6 address allocation mechanism is supported by the target UE.
- Link-Local IPv6 Address: a link-local IPv6 address formed locally based on RFC 4862 [17] if the target UE does not support the IPv6 IP address allocation mechanism, i.e. the IP Address Configuration indicates "address allocation not supported", and UE-1 included a link-local IPv6 address in the Direct Communication Request message. The target UE shall include a non-conflicting link-local IPv6 address.
- If both UEs (i.e. the initiating UE and the target UE) are selected to use link-local IPv6 address, they shall disable the duplicate address detection defined in RFC 4862 [17].
- NOTE 3: When either the initiating UE or the target UE indicates the support of IPv6 routing, the corresponding

address configuration procedure would be carried out after the establishment of the layer 2 link, and the link-local IPv6 addresses are ignored.

The ProSe layer of the UE that established PC5 unicast link passes the PC5 Link Identifier assigned for the unicast link and the PC5 unicast link related information down to the AS layer. The PC5 unicast link related information includes Layer-2 ID information (i.e. source Layer-2 ID and destination Layer-2 ID). This enables the AS layer to maintain the PC5 Link Identifier together with the PC5 unicast link related information.

6. ProSe data is transmitted over the established unicast link as below:

The PC5 Link Identifier and PFI are provided to the AS layer, together with the ProSe data. Optionally in addition, the Layer-2 ID information (i.e. source Layer-2 ID and destination Layer-2 ID) is provided to the AS layer.

NOTE 4: It is up to UE implementation to provide the Layer-2 ID information to the AS layer. UE-1 sends the ProSe data using the source Layer-2 ID (i.e. UE-Vs Layer-2 ID for this unicast link) and the destination Layer-2 ID (i.e. the peer UE's Layer-2 ID for this unicast link).

NOTE 5: PC5 unicast link is bi-directional, therefore the peer UE of UE-1 can send the ProSe data to UE-1 over the unicast link with UE-1.

[. . .]

6.4.3.6 Layer-2 Link Management Over PC5 Reference Point for 5G ProSe UE-to-Network Relay

The Layer-2 link procedures over PC5 reference point for unicast mode 5G ProSe Direct Communication as depicted from clause 6.4.3.1 to clause 6.4.3.5 can be used for the PC5 reference point between 5G ProSe Remote UE and 5G ProSe UE-to-Network Relay, with the following differences and clarifications:

The Layer-2 link modification procedure is applicable to ProSe Communication via 5G ProSe Layer-3 UE-to-Network Relay, other procedures are applicable to both ProSe Communication via 5G ProSe Layer-2 UE-to-Network Relay and ProSe Communication via 5G ProSe Layer-3 UE-to-Network Relay.

Editor's note: Whether the Layer-2 link modification procedure is also applicable to ProSe Communication via 5G ProSe Layer-2 UE-to-Network Relay requires cooperation with RAN2.

The UE oriented Layer-2 link establishment is used with UE-1 representing the 5G ProSe Remote UE and UE-2 representing the 5G ProSe UE-to-Network Relay. For other procedures either UE-1 represents the 5G ProSe Remote UE and UE-2 represents the 5G ProSe UE-to-Network Relay, or UE-1 represents the 5G ProSe UE-to-Network Relay and UE-2 represents the 5G ProSe Remote UE. I.e. the Layer-2 link establishment is initiated by the 5G ProSe Remote UE, while other procedures may be initiated either by the 5G ProSe Remote UE or by the 5G ProSe UE-to-Network Relay.

For the UE oriented Layer-2 link establishment as described in the clause 6.4.3.1,

In step 1, the 5G ProSe Remote UE determines the destination Layer-2 ID for PC5 unicast link establishment based on the unicast source Layer-2 ID of the

selected 5G ProSe UE-to-Network relay (as specified in clause 5.8.3) during UE-to-Network Relay discovery as specified in clause 6.3.2.3.

In step 2, 5G ProSe Remote UE (UE-1) determines the Relay Service Code to be used. The Relay Service Code to be used is selected from the received Relay Service Code(s) during UE-to-Network Relay discovery as specified in clause 6.3.2.3.

In step 3, 5G ProSe Remote UE (UE-1) sends a unicast Direct Communication Request message to the selected 5G ProSe UE-to-Network Relay. The destination Layer-2 ID used to send the Direct Communication Request message shall be unicast Layer-2 ID as determined in step 1. The Direct Communication Request message includes:

Source User Info: the identity of the Remote UE requesting relay operation.

Target User Info: the identity of the UE-to-Network Relay provided to the 5G ProSe Remote UE during UE-to-Network Relay Discovery procedure.

Relay Service Code: indicates the connectivity service provided by the 5G ProSe UE-to-Network Relay as requested by the 5G ProSe Remote UE.

Security Information: the information for the establishment of security.

In step 4 and step 5, step 4a and step 5a are performed if the 5G ProSe UE-to-Network Relay's identity matches the identity provided in the Target User Info and the Relay Service Code is one of the Relay Service Codes included during UE-to-Network Relay discovery as specified in clause 6.3.2.3. The Source User Info in the Direct Communication Accept message is the identity of the UE-to-Network Relay. In case of 5G ProSe Layer-2 UE-to-Network Relay, the Remote UE does not send the IP Address Configuration, Link-Local IPv6 Address and QoS Info to the 5G ProSe Layer-2 UE-to-Network Relay, and the Direct Communication Accept message does not include IP Address Configuration, Link-Local IPv6 Address and QoS Info. In case of 5G ProSe Layer-3 UE-to-Network Relay, the Direct Communication Accept message does not include the IP Address Configuration indicating the value "address allocation not supported".

In case of 5G ProSe Layer-2 UE-to-Network Relay, step 6 is not performed.

For the Layer-2 link release as described in the clause 6.4.3.3,

In step1, if the Layer-2 link release procedure is initiated by the 5G ProSe UE-to-Network Relay, the Disconnect Request message may indicate the 5G ProSe UE-to-Network Relay is temporarily not available as described in clause 5.12.

NOTE: The form of the temporarily not available indication will be determined by stage 3.

If the service authorization for acting as a 5G ProSe Remote UE or as a 5G ProSe UE-to-Network Relay is revoked, the 5G ProSe UE-to-Network Relay should initiate the release of the layer-2 link that the revoked authorization affects.

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For the Layer-2 link modification as described in the clause 6.4.3.4,

In step1, the Layer-2 link modification procedure may be initiated by the 5G ProSe Layer-3 Remote UE based on the application information received from its ProSe application layer. The Link Modification Request message may include the PC5 QoS Rule(s) for the PC5 QoS Flow(s) to be added or modified as described in clause 5.6.2.1. The Layer-2 link modification procedure may be initiated by the 5G ProSe Layer-3 UE-to-Network Relay based on the information received from the SMF via NAS signalling from SMF.

A 5G ProSe Remote UE and a 5G ProSe UE-to-Network Relay shall set up a separate PC5 unicast links if an existing unicast link(s) was established with a different Relay Service Code or without a Relay Service Code.

3GPP TS 38.331 introduced the following:

5.2.2.3.3 Request for on Demand System Information

The UE shall:

1> if SIB1 includes si-SchedulingInfo containing si-RequestConfigSUL and criteria to select supplementary uplink as defined in TS 38.321[13], clause 5.1.1 is met:

[. . .]

1> else if SIB1 includes si-SchedulingInfo containing si-RequestConfig and criteria to select normal uplink as defined in TS 38.321[13], clause 5.1.1 is met:

[. . .]

1> else:

2> apply the default L1 parameter values as specified in corresponding physical layer specifications except for the parameters for which values are provided in SIB1;

2> apply the default MAC Cell Group configuration as specified in 9.2.2;

2> apply the timeAlignmentTimerCommon included in SIB1;

2> apply the CCCH configuration as specified in 9.1.1.2;

2> initiate transmission of the RRCSystemInfoRequest message in accordance with 5.2.2.3.4;

2> if acknowledgement for RRCSystemInfoRequest message is received from lower layers:

3> acquire the requested SI message(s) as defined in sub-clause 5.2.2.3.2, immediately;

1> if cell reselection occurs while waiting for the acknowledgment for SI request from lower layers:

2> reset MAC;

2> if SI request is based on RRCSystemInfoRequest message:

3> release RLC entity for SRB0.

[. . .]

5.3.3 RRC Connection Establishment

5.3.3.1 General

FIG. 5.3.3.1-1 of 3GPP TS 38.331 V16.6.0, Entitled “RRC Connection Establishment, Successful”, is Reproduced as FIG. 9

[. . .]

The purpose of this procedure is to establish an RRC connection. RRC connection establishment involves SRB1 establishment. The procedure is also used to transfer the initial NAS dedicated information/message from the UE to the network.

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The network applies the procedure e.g. as follows:

When establishing an RRC connection;

When UE is resuming or re-establishing an RRC connection, and the network is not able to retrieve or verify the UE context. In this case, UE receives RRCSetup and responds with RRCSetupComplete.

[. . .]

5.3.7 RRC Connection Re-Establishment

5.3.7.1 General

FIG. 5.3.7.1-1 of 3GPP TS 38.331 V16.6.0, Entitled “RRC Connection Re-Establishment, Successful”, is Reproduced as FIG. 10

[. . .]

The purpose of this procedure is to re-establish the RRC connection. A UE in RRC_CONNECTED, for which AS security has been activated with SRB2 and at least one DRB setup or, for IAB, SRB2, may initiate the procedure in order to continue the RRC connection. The connection re-establishment succeeds if the network is able to find and verify a valid UE context or, if the UE context cannot be retrieved, and the network responds with an RRCSetup according to clause 5.3.3.4.

The network applies the procedure e.g as follows:

When AS security has been activated and the network retrieves or verifies the UE context:

to re-activate AS security without changing algorithms;
to re-establish and resume the SRB1;

When UE is re-establishing an RRC connection, and the network is not able to retrieve or verify the UE context:
to discard the stored AS Context and release all RBs and BH RLC channels;

to fallback to establish a new RRC connection.

If AS security has not been activated, the UE shall not initiate the procedure but instead moves to RRC_IDLE directly, with release cause ‘other’. If AS security has been activated, but SRB2 and at least one DRB or, for IAB, SRB2, are not setup, the UE does not initiate the procedure but instead moves to RRC_IDLE directly, with release cause ‘RRC connection failure’.

5.3.7.2 Initiation

The UE initiates the procedure when one of the following conditions is met:

1> upon detecting radio link failure of the MCG and t316 is not configured, in accordance with 5.3.10; or

1> upon detecting radio link failure of the MCG while SCG transmission is suspended, in accordance with 5.3.10; or

1> upon detecting radio link failure of the MCG while PSCell change or PSCell addition is ongoing, in accordance with 5.3.10; or

1> upon re-configuration with sync failure of the MCG, in accordance with sub-clause 5.3.5.8.3; or

1> upon mobility from NR failure, in accordance with sub-clause 5.4.3.5; or

1> upon integrity check failure indication from lower layers concerning SRB1 or SRB2, except if the integrity check failure is detected on the RRCReestablishment message; or

1> upon an RRC connection reconfiguration failure, in accordance with sub-clause 5.3.5.8.2; or

1> upon detecting radio link failure for the SCG while MCG transmission is suspended, in accordance with subclause 5.3.10.3 in NR-DC or in accordance with TS 36.331 [10] subclause 5.3.11.3 in NE-DC; or

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- 1> upon reconfiguration with sync failure of the SCG while MCG transmission is suspended in accordance with subclause 5.3.5.8.3; or
 - 1> upon SCG change failure while MCG transmission is suspended in accordance with TS 36.331 [10] sub-clause 5.3.5.7a; or
 - 1> upon SCG configuration failure while MCG transmission is suspended in accordance with subclause 5.3.5.8.2 in NR-DC or in accordance with TS 36.331 [10] subclause 5.3.5.5 in NE-DC; or
 - 1> upon integrity check failure indication from SCG lower layers concerning SRB3 while MCG is suspended; or
 - 1> upon T316 expiry, in accordance with sub-clause 5.7.3b.5.
- Upon initiation of the procedure, the UE shall:
- 1> stop timer T310, if running;
 - 1> stop timer T312, if running;
 - 1> stop timer T304, if running;
 - 1> start timer T311;
 - 1> stop timer T316, if running;
 - 1> if UE is not configured with conditionalReconfiguration:
 - 2> reset MAC;
 - 2> release spCellConfig, if configured;
 - 2> suspend all RBs, and BH RLC channels for IAB-MT, except SRB0;
 - 2> release the MCG SCell(s), if configured;
 - 2> if MR-DC is configured:
 - 3> perform MR-DC release, as specified in clause 5.3.5.10;
 - 2> release delayBudgetReportingConfig, if configured and stop timer T342, if running;
 - 2> release overheatingAssistanceConfig, if configured and stop timer T345, if running;
 - 2> release idc-AssistanceConfig, if configured;
 - 2> release btNameList, if configured;
 - 2> release wlanNameList, if configured;
 - 2> release sensorNameList, if configured;
 - 2> release drx-PreferenceConfig for the MCG, if configured and stop timer T346a associated with the MCG, if running;
 - 2> release maxBW-PreferenceConfig for the MCG, if configured and stop timer T346b associated with the MCG, if running;
 - 2> release maxCC-PreferenceConfig for the MCG, if configured and stop timer T346c associated with the MCG, if running;
 - 2> release maxMIMO-LayerPreferenceConfig for the MCG, if configured and stop timer T346d associated with the MCG, if running;
 - 2> release minSchedulingOffsetPreferenceConfig for the MCG, if configured stop timer T346e associated with the MCG, if running;
 - 2> release releasePreferenceConfig, if configured stop timer T346f, if running;
 - 2> release onDemandSIB-Request if configured, and stop timer T350, if running;
 - 2> release referenceTimePreferenceReporting, if configured;
 - 2> release sl-AssistanceConfigNR, if configured;
 - 2> release obtain CommonLocation, if configured;

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- 1> if any DAPS bearer is configured:
 - 2> reset the source MAC and release the source MAC configuration;
 - 2> for each DAPS bearer:
 - 3> release the RLC entity or entities as specified in TS 38.322 [4], clause 5.1.3, and the associated logical channel for the source SpCell;
 - 3> reconfigure the PDCP entity to release DAPS as specified in TS 38.323 [5];
 - 2> for each SRB:
 - 3> release the PDCP entity for the source SpCell;
 - 3> release the RLC entity as specified in TS 38.322 [4], clause 5.1.3, and the associated logical channel for the source SpCell;
 - 2> release the physical channel configuration for the source SpCell;
 - 2> discard the keys used in the source SpCell (the K_{gNB} key, the K_{RRCenc} key, the K_{RRCint} key, the K_{UPint} key and the K_{UPenc} key), if any;
 - 1> perform cell selection in accordance with the cell selection process as specified in TS 38.304 [20].
- 5.3.7.3 Actions Following Cell Selection while T311 is Running
- Upon selecting a suitable NR cell, the UE shall:
- 1> ensure having valid and up to date essential system information as specified in clause 5.2.2.2;
 - 1> stop timer T311;
 - 1> if T390 is running:
 - 2> stop timer T390 for all access categories;
 - 2> perform the actions as specified in 5.3.14.4;
 - 1> if the cell selection is triggered by detecting radio link failure of the MCG or re-configuration with sync failure of the MCG or mobility from NR failure, and
 - 1> if attemptCondReconfig is configured; and
 - 1> if the selected cell is one of the candidate cells for which the reconfigurationWithSync is included in the masterCellGroup in VarConditionalReconfig:
 - 2> apply the stored condRRCReconfig associated to the selected cell and perform actions as specified in 5.3.5.3;
- NOTE 1: It is left to network implementation to how to avoid keystream reuse in case of CHO based recovery after a failed handover without key change.
- 1> else:
 - 2> if UE is configured with conditionalReconfiguration:
 - 3> reset MAC;
 - 3> release spCellConfig, if configured;
 - 3> release the MCG SCell(s), if configured;
 - 3> release delayBudgetReportingConfig, if configured and stop timer T342, if running;
 - 3> release overheatingAssistanceConfig, if configured and stop timer T345, if running;
 - 3> if MR-DC is configured:
 - 4> perform MR-DC release, as specified in clause 5.3.5.10;
 - 3> release idc-AssistanceConfig, if configured;
 - 3> release btNameList, if configured;
 - 3> release wlanNameList, if configured;
 - 3> release sensorNameList, if configured;
 - 3> release drx-PreferenceConfig for the MCG, if configured and stop timer T346a associated with the MCG, if running;
 - 3> release maxBW-PreferenceConfig for the MCG, if configured and stop timer T346b associated with the MCG, if running;

- 3> release maxCC-PreferenceConfig for the MCG, if configured and stop timer T346c associated with the MCG, if running;
 - 3> release maxMIMO-LayerPreferenceConfig for the MCG, if configured and stop timer T346d associated with the MCG, if running;
 - 3> release minSchedulingOffsetPreferenceConfig for the MCG, if configured and stop timer T346e associated with the MCG, if running;
 - 3> release releasePreferenceConfig, if configured and stop timer T346f, if running;
 - 3> release onDemandSIB-Request if configured, and stop timer T350, if running;
 - 3> release referenceTimePreferenceReporting, if configured;
 - 3> release sl-AssistanceConfigNR, if configured;
 - 3> release obtain CommonLocation, if configured;
 - 3> suspend all RBs, except SRB0;
 - 2> remove all the entries within VarConditionalRecon-fig, if any;
 - 2> for each measId, if the associated reportConfig has a reportType set to condTriggerConfig:
 - 3> for the associated reportConfigId:
 - 4> remove the entry with the matching reportCon-figId from the reportConfigList within the VarMeasConfig;
 - 3> if the associated measObjectId is only associated to a reportConfig with reportType set to condTrig-gerConfig:
 - 4> remove the entry with the matching measOb-jectId from the measObjectList within the VarMeasConfig;
 - 3> remove the entry with the matching measId from the measIdList within the VarMeasConfig;
 - 2> start timer T301;
 - 2> apply the default L1 parameter values as specified in corresponding physical layer specifications except for the parameters for which values are provided in SIB1;
 - 2> apply the default MAC Cell Group configuration as specified in 9.2.2;
 - 2> apply the CCCH configuration as specified in 9.1.1.2;
 - 2> apply the timeAlignmentTimerCommon included in SIB1;
 - 2> initiate transmission of the RRCReestablishmentRe-quest message in accordance with 5.3.7.4;
- NOTE 2: This procedure applies also if the UE returns to the source PCell. Upon selecting an inter-RAT cell, the UE shall:
- 1> perform the actions upon going to RRC_IDLE as specified in 5.3.11, with release cause 'RRC connection failure'.
- 5.3.7.4 Actions Related to Transmission of RRCReestab-lishmentRequest Message
- The UE shall set the contents of RRCReestablishmentRe-quest message as follows:
- 1> if the procedure was initiated due to radio link failure as specified in 5.3.10.3 or reconfiguration with sync failure as specified in 5.3.5.8.3:
 - 2> set the reestablishmentCellId in the VarRLF-Report to the global cell identity of the selected cell;
 - 1> set the ue-Identity as follows:
 - 2> set the c-RNTI to the C-RNTI used in the source PCell (reconfiguration with sync or mobility from NR failure) or used in the PCell in which the trigger for the re-establishment occurred (other cases);

- 2> set the physCellId to the physical cell identity of the source PCell (reconfiguration with sync or mobility from NR failure) or of the PCell in which the trigger for the re-establishment occurred (other cases);
 - 2> set the shortMAC-I to the 16 least significant bits of the MAC-I calculated:
 - 3> over the ASN.1 encoded as per clause 8 (i.e., a multiple of 8 bits) VarShortMAC-Input;
 - 3> with the K_{RRCint} key and integrity protection algorithm that was used in the source PCell (re-configuration with sync or mobility from NR failure) or of the PCell in which the trigger for the re-establishment occurred (other cases); and
 - 3> with all input bits for COUNT, BEARER and DIRECTION set to binary ones;
 - 1> set the reestablishmentCause as follows:
 - 2> if the re-establishment procedure was initiated due to reconfiguration failure as specified in 5.3.5.8.2:
 - 3> set the reestablishmentCause to the value recon-figurationFailure;
 - 2> else if the re-establishment procedure was initiated due to reconfiguration with sync failure as specified in 5.3.5.8.3 (intra-NR handover failure) or 5.4.3.5 (inter-RAT mobility from NR failure):
 - 3> set the reestablishmentCause to the value han-doverFailure;
 - 2> else:
 - 3> set the reestablishmentCause to the value other-Failure;
 - 1> re-establish PDCP for SRB1;
 - 1> re-establish RLC for SRB1;
 - 1> apply the default configuration defined in 9.2.1 for SRB1;
 - 1> configure lower layers to suspend integrity protection and ciphering for SRB1;
- NOTE: Ciphering is not applied for the subsequent RRCReestablishment message used to resume the con-nection. An integrity check is performed by lower layers, but merely upon request from RRC.
- 1> resume SRB1;
 - 1> submit the RRCReestablishmentRequest message to lower layers for transmission.
- 5.3.7.5 Reception of the RRCReestablishment by the UE
- The UE shall:
- 1> stop timer T301;
 - 1> consider the current cell to be the PCell;
 - 1> store the nextHopChainingCount value indicated in the RRCReestablishment message;
 - 1> update the K_{gNB} key based on the current K_{gNB} key or the NH, using the stored nextHopChainingCount value, as specified in TS 33.501 [11];
 - 1> derive the K_{RRCenc} and K_{UPenc} keys associated with the previously configured cipheringAlgorithm, as specified in TS 33.501 [11];
 - 1> derive the K_{RRCint} and K_{UPint} keys associated with the previously configured integrityProtAlgorithm, as speci-fied in TS 33.501 [11].
 - 1> request lower layers to verify the integrity protection of the RRCReestablishment message, using the previ-ously configured algorithm and the K_{RRCint} key;
 - 1> if the integrity protection check of the RRCReestab-lishment message fails:
 - 2> perform the actions upon going to RRC_IDLE as specified in 5.3.11, with release cause 'RRC connec-tion failure', upon which the procedure ends;
 - 1> configure lower layers to resume integrity protection for SRB1 using the previously configured algorithm

- and the K_{RRCint} key immediately, i.e., integrity protection shall be applied to all subsequent messages received and sent by the UE, including the message used to indicate the successful completion of the procedure;
- 1> configure lower layers to resume ciphering for SRB1 using the previously configured algorithm and, the K_{RRCenc} key immediately, i.e., ciphering shall be applied to all subsequent messages received and sent by the UE, including the message used to indicate the successful completion of the procedure;
 - 1> release the measurement gap configuration indicated by the measGapConfig, if configured;
 - 1> set the content of RRCReestablishmentComplete message as follows:
 - 2> if the UE has logged measurements available for NR and if the RPLMN is included in plmn-IdentityList stored in VarLogMeasReport:
 - 3> include the logMeasAvailable in the RRCReestablishmentComplete message;
 - 3> if Bluetooth measurement results are included in the logged measurements the UE has available for NR:
 - 4> include the logMeasAvailableBT in the RRCReestablishmentComplete message;
 - 3> if WLAN measurement results are included in the logged measurements the UE has available for NR:
 - 4> include the logMeasAvailableWLAN in the RRCReestablishmentComplete message;
 - 2> if the UE has connection establishment failure or connection resume failure information available in VarConnEstFailReport and if the RPLMN is equal to plmn-Identity stored in VarConnEstFailReport:
 - 3> include connEstFailInfoAvailable in the RRCReestablishmentComplete message;
 - 2> if the UE has radio link failure or handover failure information available in VarRLF-Report and if the RPLMN is included in plmn-IdentityList stored in VarRLF-Report; or
 - 2> if the UE has radio link failure or handover failure information available in VarRLF-Report of TS 36.331 [10] and if the UE is capable of cross-RAT RLF reporting and if the RPLMN is included in plmn-IdentityList stored in VarRLF-Report of TS 36.331 [10]:
 - 3> include rlf-InfoAvailable in the RRCReestablishmentComplete message;
 - 1> submit the RRCReestablishmentComplete message to lower layers for transmission;
 - 1> the procedure ends.

[. . .]

5.8.3 Sidelink UE Information for NR Sidelink Communication

5.8.3.1 General

FIG. 5.8.3.1-1 of 3GPP TS 38.331 V16.6.0, Entitled "Sidelink UE Information for NR Sidelink Communication", is Reproduced as FIG. 11

The purpose of this procedure is to inform the network that the UE:

- is interested or no longer interested to receive or transmit NR sidelink communication,
- is requesting assignment or release of transmission resource for NR sidelink communication,

- is reporting QoS parameters and QoS profile(s) related to NR sidelink communication,
- is reporting that a sidelink radio link failure or sidelink RRC reconfiguration failure has been detected,
- is reporting the sidelink UE capability information of the associated peer UE for unicast communication,
- is reporting the RLC mode information of the sidelink data radio bearer(s) received from the associated peer UE for unicast communication.

5.8.3.2 Initiation

A UE capable of NR sidelink communication that is in RRC_CONNECTED may initiate the procedure to indicate it is (interested in) receiving or transmitting NR sidelink communication in several cases including upon successful connection establishment or resuming, upon change of interest, upon changing QoS profiles, upon receiving UECapabilityInformationSidelink from the associated peer UE, upon RLC mode information updated from the associated peer UE or upon change to a PCell providing SIB12 including sl-ConfigCommonNR. A UE capable of NR sidelink communication may initiate the procedure to request assignment of dedicated sidelink DRB configuration and transmission resources for NR sidelink communication transmission. A UE capable of NR sidelink communication may initiate the procedure to report to the network that a sidelink radio link failure or sidelink RRC reconfiguration failure has been declared. Upon initiating this procedure, the UE shall:

- 1> if SIB12 including sl-ConfigCommonNR is provided by the PCell:
 - 2> ensure having a valid version of SIB12 for the PCell;
 - 2> if configured by upper layers to receive NR sidelink communication on the frequency included in sl-FreqInfoList in SIB12 of the PCell:
 - 3> if the UE did not transmit a SidelinkUEInformationNR message since last entering RRC_CONNECTED state; or
 - 3> if since the last time the UE transmitted a SidelinkUEInformationNR message the UE connected to a PCell not providing SIB12 including sl-ConfigCommonNR; or
 - 3> if the last transmission of the SidelinkUEInformationNR message did not include sl-RxInterestedFreqList; or if the frequency configured by upper layers to receive NR sidelink communication on has changed since the last transmission of the SidelinkUEInformationNR message:
 - 4> initiate transmission of the SidelinkUEInformationNR message to indicate the NR sidelink communication reception frequency of interest in accordance with 5.8.3.3;
 - 2> else:
 - 3> if the last transmission of the SidelinkUEInformationNR message included sl-RxInterestedFreqList:
 - 4> initiate transmission of the SidelinkUEInformationNR message to indicate it is no longer interested in NR sidelink communication reception in accordance with 5.8.3.3;
 - 2> if configured by upper layers to transmit NR sidelink communication on the frequency included in sl-FreqInfoList in SIB12 of the PCell:
 - 3> if the UE did not transmit a SidelinkUEInformationNR message since last entering RRC_CONNECTED state; or
 - 3> if since the last time the UE transmitted a SidelinkUEInformationNR message the UE con-

connected to a PCell not providing SIB12 including sl-ConfigCommonNR; or

3> if the last transmission of the SidelinkUEInformationNR message did not include sl-TxResourceReqList; or if the information carried by the sl-TxResourceReqList has changed since the last transmission of the SidelinkUEInformationNR message:

4> initiate transmission of the SidelinkUEInformationNR message to indicate the NR sidelink communication transmission resources required by the UE in accordance with 5.8.3.3;

2> else:

3> if the last transmission of the SidelinkUEInformationNR message included sl-TxResourceReqList:

4> initiate transmission of the SidelinkUEInformationNR message to indicate it no longer requires NR sidelink communication transmission resources in accordance with 5.8.3.3.

5.8.3.3 Actions Related to Transmission of SidelinkUEInformationNR Message

The UE shall set the contents of the SidelinkUEInformationNR message as follows:

1> if the UE initiates the procedure to indicate it is (no more) interested to receive NR sidelink communication or to request (configuration/release) of NR sidelink communication transmission resources or to report to the network that a sidelink radio link failure or sidelink RRC reconfiguration failure has been declared (i.e. UE includes all concerned information, irrespective of what triggered the procedure):

2> if SIB12 including sl-ConfigCommonNR is provided by the PCell:

3> if configured by upper layers to receive NR sidelink communication:

4> include sl-RxInterestedFreqList and set it to the frequency for NR sidelink communication reception;

3> if configured by upper layers to transmit NR sidelink communication:

4> include sl-TxResourceReqList and set its fields (if needed) as follows for each destination for which it requests network to assign NR sidelink communication resource:

5> set sl-DestinationIdentity to the destination identity configured by upper layer for NR sidelink communication transmission;

5> set sl-CastType to the cast type of the associated destination identity configured by the upper layer for the NR sidelink communication transmission;

5> set sl-RLC-ModeIndication to include the RLC mode(s) and optionally QoS profile(s) of the sidelink QoS flow(s) of the associated RLC mode(s), if the associated bi-directional sidelink DRB has been established due to the configuration by RRCReconfigurationSidelink;

5> set sl-QoS-InfoList to include QoS profile(s) of the sidelink QoS flow(s) of the associated destination configured by the upper layer for the NR sidelink communication transmission;

5> set sl-InterestedFreqList to indicate the frequency of the associated destination for NR sidelink communication transmission;

5> set sl-TypeTxSyncList to the current synchronization reference type used on the associ-

ated sl-InterestedFreqList for NR sidelink communication transmission.

5> set sl-CapabilityInformationSidelink to include UECapabilityInformationSidelink message, if any, received from peer UE.

4> if a sidelink radio link failure or a sidelink RRC reconfiguration failure has been declared, according to clauses 5.8.9.3 and 5.8.9.1.8, respectively;

5> include sl-FailureList and set its fields as follows for each destination for which it reports the NR sidelink communication failure:

6> set sl-DestinationIdentity to the destination identity configured by upper layer for NR sidelink communication transmission;

6> if the sidelink RLF is detected as specified in sub-clause 5.8.9.3:

7> set sl-Failure as rlf for the associated destination for the NR sidelink communication transmission;

6> else if RRCReconfigurationFailureSidelink is received:

7> set sl-Failure as configFailure for the associated destination for the NR sidelink communication transmission;

1> if the UE initiates the procedure while connected to an E-UTRA PCell:

2> submit the SidelinkUEInformationNR to lower layers via SRB1, embedded in E-UTRA RRC message ULInformationTransferIRAT as specified in TS 36.331 [10], clause 5.6.28;

1> else:

2> submit the SidelinkUEInformationNR message to lower layers for transmission.

[. . .]

5.8.9 Sidelink RRC Procedure

5.8.9.1 Sidelink RRC Reconfiguration

5.8.9.1.1 General

FIG. 5.8.9.1.1-1 of 3GPP TS 38.331 V16.6.0, Entitled "Sidelink RRC Reconfiguration, Successful", is reproduced as FIG. 12

[. . .]

45 The purpose of this procedure is to modify a PC5-RRC connection, e.g. to establish/modify/release sidelink DRBs, to (re-)configure NR sidelink measurement and reporting, to (re-)configure sidelink CSI reference signal resources and CSI reporting latency bound.

50 The UE may initiate the sidelink RRC reconfiguration procedure and perform the operation in sub-clause 5.8.9.1.2 on the corresponding PC5-RRC connection in following cases:

the release of sidelink DRBs associated with the peer UE, as specified in sub-clause 5.8.9.1a.1;

the establishment of sidelink DRBs associated with the peer UE, as specified in sub-clause 5.8.9.1a.2;

the modification for the parameters included in SLRB-Config of sidelink DRBs associated with the peer UE, as specified in sub-clause 5.8.9.1a.2;

the (re-)configuration of the peer UE to perform NR sidelink measurement and report.

the (re-)configuration of the sidelink CSI reference signal resources and CSI reporting latency bound.

65 In RRC_CONNECTED, the UE applies the NR sidelink communications parameters provided in RRCReconfiguration (if any). In RRC_IDLE or RRC_INACTIVE, the UE

applies the NR sidelink communications parameters provided in system information (if any). For other cases, UEs apply the NR sidelink communications parameters provided in SidelinkPreconfigNR (if any). When UE performs state transition between above three cases, the UE applies the NR sidelink communications parameters provided in the new state, after acquisition of the new configurations. Before acquisition of the new configurations, UE continues applying the NR sidelink communications parameters provided in the old state.

5.8.9.1.2 Actions Related to Transmission of RRCReconfigurationSidelink Message

The UE shall set the contents of RRCReconfigurationSidelink message as follows:

1> for each sidelink DRB that is to be released, according to sub-clause 5.8.9.1a.1.1, due to configuration by sl-ConfigDedicatedNR, SIB12, SidelinkPreconfigNR or by upper layers:

2> set the SLRB-PC5-ConfigIndex included in the slrb-ConfigToReleaseList corresponding to the sidelink DRB;

1> for each sidelink DRB that is to be established or modified, according to sub-clause 5.8.9.1a.2.1, due to receiving sl-ConfigDedicatedNR, SIB12 or SidelinkPreconfigNR:

2> set the SLRB-Config included in the slrb-ConfigToAddModList, according to the received sl-RadioBearerConfig and sl-RLC-BearerConfig corresponding to the sidelink DRB;

1> set the sl-MeasConfig as follows:

2> If the frequency used for NR sidelink communication is included in sl-FreqInfoToAddModList in sl-ConfigDedicatedNR within RRCReconfiguration message or included in sl-ConfigCommonNR within SIB12:

3> if UE is in RRC_CONNECTED:

4> set the sl-MeasConfig according to stored NR sidelink measurement configuration information for this destination;

3> if UE is in RRC_IDLE or RRC_INACTIVE:

4> set the sl-MeasConfig according to stored NR sidelink measurement configuration received from SIB12;

2> else:

3> set the sl-MeasConfig according to the sl-MeasPreconfig in SidelinkPreconfigNR;

1> start timer T400 for the destination associated with the sidelink DRB;

1> set the sl-CSI-RS-Config;

1> set the sl-LatencyBoundCSI-Report,

NOTE 1: How to set the parameters included in sl-CSI-RS-Config and sl-LatencyBoundCSI-Report is up to UE implementation.

The UE shall submit the RRCReconfigurationSidelink message to lower layers for transmission.

5.8.9.1.3 Reception of an RRCReconfigurationSidelink by the UE

The UE shall perform the following actions upon reception of the RRCReconfigurationSidelink:

1> if the RRCReconfigurationSidelink includes the sl-ResetConfig:

2> perform the sidelink reset configuration procedure as specified in 5.8.9.1.10;

1> if the RRCReconfigurationSidelink includes the slrb-ConfigToReleaseList:

2> for each SLRB-PC5-ConfigIndex value included in the slrb-ConfigToReleaseList that is part of the current UE sidelink configuration;

3> perform the sidelink DRB release procedure, according to sub-clause 5.8.9.1a.1;

1> if the RRCReconfigurationSidelink includes the slrb-ConfigToAddModList:

2> for each slrb-PC5-ConfigIndex value included in the slrb-ConfigToAddModList that is not part of the current UE sidelink configuration:

3> if sl-MappedQoS-FlowsToAddList is included:

4> apply the SL-PQFI included in sl-MappedQoS-FlowsToAddList;

3> perform the sidelink DRB addition procedure, according to sub-clause 5.8.9.1a.2;

2> for each slrb-PC5-ConfigIndex value included in the slrb-ConfigToAddModList that is part of the current UE sidelink configuration:

3> if sl-MappedQoS-FlowsToAddList is included:

4> add the SL-PQFI included in sl-MappedQoS-FlowsToAddList to the corresponding sidelink DRB;

3> if sl-MappedQoS-FlowsToReleaseList is included:

4> remove the SL-PQFI included in sl-MappedQoS-FlowsToReleaseList from the corresponding sidelink DRB;

3> if the sidelink DRB release conditions as described in sub-clause 5.8.9.1a.1.1 are met:

4> perform the sidelink DRB release procedure according to sub-clause 5.8.9.1a.1.2;

3> else if the sidelink DRB modification conditions as described in sub-clause 5.8.9.1a.2.1 are met:

4> perform the sidelink DRB modification procedure according to sub-clause 5.8.9.1a.2.2;

1> if the RRCReconfigurationSidelink message includes the sl-MeasConfig:

2> perform the sidelink measurement configuration procedure as specified in 5.8.10;

1> if the RRCReconfigurationSidelink message includes the sl-CSI-RS-Config:

2> apply the sidelink CSI-RS configuration;

1> if the RRCReconfigurationSidelink message includes the sl-LatencyBoundCSI-Report:

2> apply the configured sidelink CSI report latency bound;

1> if the UE is unable to comply with (part of) the configuration included in the RRCReconfigurationSidelink (i.e. sidelink RRC reconfiguration failure):

2> continue using the configuration used prior to the reception of the RRCReconfigurationSidelink message;

2> set the content of the RRCReconfigurationFailureSidelink message;

3> submit the RRCReconfigurationFailureSidelink message to lower layers for transmission;

1> else:

2> set the content of the RRCReconfigurationCompleteSidelink message;

3> submit the RRCReconfigurationCompleteSidelink message to lower layers for transmission;

NOTE 1: When the same logical channel is configured with different RLC mode by another UE, the UE handles the case as sidelink RRC reconfiguration failure.

[. . .]

5.8.9.1a.3 Sidelink SRB Release

The UE shall:

- 1> if a PC5-RRC connection release for a specific destination is requested by upper layers; or
- 1> if the sidelink radio link failure is detected for a specific destination:
 - 2> release the PDCP entity, RLC entity and the logical channel of the sidelink SRB for PC5-RRC message of the specific destination;
 - 2> consider the PC5-RRC connection is released for the destination.
- 1> if PC5-S transmission for a specific destination is terminated in upper layers:
 - 2> release the PDCP entity, RLC entity and the logical channel of the sidelink SRB(s) for PC5-S message of the specific destination;

5.8.9.1a.4 Sidelink SRB Addition

The UE shall:

- 1> if transmission of PC5-S message for a specific destination is requested by upper layers for sidelink SRB:
 - 2> establish PDCP entity, RLC entity and the logical channel of a sidelink SRB for PC5-S message, as specified in sub-clause 9.1.1.4;
- 1> if a PC5-RRC connection establishment for a specific destination is indicated by upper layers:
 - 2> establish PDCP entity, RLC entity and the logical channel of a sidelink SRB for PC5-RRC message of the specific destination, as specified in sub-clause 9.1.1.4;
 - 2> consider the PC5-RRC connection is established for the destination.

[. . .]

5.8.9.3 Sidelink Radio Link Failure Related Actions

The UE shall:

- 1> upon indication from sidelink RLC entity that the maximum number of retransmissions for a specific destination has been reached; or
- 1> upon T400 expiry for a specific destination; or
- 1> upon indication from MAC entity that the maximum number of consecutive HARQ DTX for a specific destination has been reached; or
- 1> upon integrity check failure indication from sidelink PDCP entity concerning SL-SRB2 or SL-SRB3 for a specific destination:
 - 2> consider sidelink radio link failure to be detected for this destination;
 - 2> release the DRBs of this destination, in according to sub-clause 5.8.9.1a.1;
 - 2> release the SRBs of this destination, in according to sub-clause 5.8.9.1a.3;
 - 2> discard the NR sidelink communication related configuration of this destination;
 - 2> reset the sidelink specific MAC of this destination;
 - 2> consider the PC5-RRC connection is released for the destination;

2> indicate the release of the PC5-RRC connection to the upper layers for this destination (i.e. PC5 is unavailable);

2> if UE is in RRC_CONNECTED:

- 3> perform the sidelink UE information for NR sidelink communication procedure, as specified in 5.8.3.3;

NOTE: It is up to UE implementation on whether and how to indicate to upper layers to maintain the keep-alive procedure [55].

A running CR of TS 38.331 introduced the following:

Next Modified Subclause

5.3.7 RRC Connection Re-Establishment

[. . .]

5.3.7.2 Initiation

The UE initiates the procedure when one of the following conditions is met:

- 1> upon detecting radio link failure of the MCG and t316 is not configured, in accordance with 5.3.10; or
- 1> upon detecting radio link failure of the MCG while SCG transmission is suspended, in accordance with 5.3.10; or
- 1> upon detecting radio link failure of the MCG while PSCell change or PSCell addition is ongoing, in accordance with 5.3.10; or
- 1> upon re-configuration with sync failure of the MCG, in accordance with sub-clause 5.3.5.8.3; or
- 1> upon mobility from NR failure, in accordance with sub-clause 5.4.3.5; or
- 1> upon integrity check failure indication from lower layers concerning SRB1 or SRB2, except if the integrity check failure is detected on the RRCReestablishment message; or
- 1> upon an RRC connection reconfiguration failure, in accordance with sub-clause 5.3.5.8.2; or
- 1> upon detecting radio link failure for the SCG while MCG transmission is suspended, in accordance with subclause 5.3.10.3 in NR-DC or in accordance with TS 36.331 [10] subclause 5.3.11.3 in NE-DC; or
- 1> upon reconfiguration with sync failure of the SCG while MCG transmission is suspended in accordance with subclause 5.3.5.8.3; or
- 1> upon SCG change failure while MCG transmission is suspended in accordance with TS 36.331 [10] sub-clause 5.3.5.7a; or
- 1> upon SCG configuration failure while MCG transmission is suspended in accordance with subclause 5.3.5.8.2 in NR-DC or in accordance with TS 36.331 [10] subclause 5.3.5.5 in NE-DC; or
- 1> upon integrity check failure indication from SCG lower layers concerning SRB3 while MCG is suspended; or
- 1> upon T316 expiry, in accordance with sub-clause 5.7.3b.5; or
- 1> upon detecting sidelink radio link failure by L2 U2N Remote UE in RRC_CONNECTED, in accordance with subclause 5.8.9.3.

Upon initiation of the procedure, the UE shall:

- 1> stop timer T310, if running;
- 1> stop timer T312, if running;
- 1> stop timer T304, if running;
- 1> start timer T311;
- 1> stop timer T316, if running;

- 1> if UE is not configured with conditionalReconfiguration:
 - 2> reset MAC;
 - 2> release spCellConfig, if configured;
 - 2> suspend all RBs, and BH RLC channels for IAB-MT, except SRB0;
 - 2> release the MCG SCell(s), if configured;
 - 2> if MR-DC is configured:
 - 3> perform MR-DC release, as specified in clause 5.3.5.10;
 - 2> release delayBudgetReportingConfig, if configured and stop timer T342, if running;
 - 2> release overheatingAssistanceConfig, if configured and stop timer T345, if running;
 - 2> release idc-AssistanceConfig, if configured;
 - 2> release btNameList, if configured;
 - 2> release wlanNameList, if configured;
 - 2> release sensorNameList, if configured;
 - 2> release drx-PreferenceConfig for the MCG, if configured and stop timer T346a associated with the MCG, if running;
 - 2> release maxBW-PreferenceConfig for the MCG, if configured and stop timer T346b associated with the MCG, if running;
 - 2> release maxCC-PreferenceConfig for the MCG, if configured and stop timer T346c associated with the MCG, if running;
 - 2> release maxMIMO-LayerPreferenceConfig for the MCG, if configured and stop timer T346d associated with the MCG, if running;
 - 2> release minSchedulingOffsetPreferenceConfig for the MCG, if configured stop timer T346e associated with the MCG, if running;
 - 2> release releasePreferenceConfig, if configured stop timer T346f, if running;
 - 2> release onDemandSIB-Request if configured, and stop timer T350, if running;
 - 2> release referenceTimePreferenceReporting, if configured;
 - 2> release sl-AssistanceConfigNR, if configured;
 - 2> release obtain CommonLocation, if configured;
- 1> if any DAPS bearer is configured:
 - 2> reset the source MAC and release the source MAC configuration;
 - 2> for each DAPS bearer:
 - 3> release the RLC entity or entities as specified in TS 38.322 [4], clause 5.1.3, and the associated logical channel for the source SpCell;
 - 3> reconfigure the PDCP entity to release DAPS as specified in TS 38.323 [5];
 - 2> for each SRB:
 - 3> release the PDCP entity for the source SpCell;
 - 3> release the RLC entity as specified in TS 38.322 [4], clause 5.1.3, and the associated logical channel for the source SpCell;
 - 2> release the physical channel configuration for the source SpCell;
 - 2> discard the keys used in the source SpCell (the K_{gNB} key, the K_{RRCEnc} key, the K_{RRCint} key, the K_{UPint} key and the K_{UPenc} key), if any;
- 1> if the UE connects with a L2 U2N Relay UE via PC5-RRC connection (i.e. the UE is a L2 U2N Remote UE):
 - 1> perform either cell selection in accordance with the cell selection process as specified in TS 38.304 [20], or relay selection as specified in clause 5.8.x3.3, or both;

- 1> else:
 - 2> perform cell selection in accordance with the cell selection process as specified in TS
- [. . .]
- 5.3.7.3a Actions Following Relay Selection while [T311] is Running

Upon selecting a suitable L2 U2N Relay UE, the L2 U2N Remote UE shall:

 - 1> ensure having valid and up to date essential system information as specified in clause 5.2.2.2;
 - 1> stop timer [T311];
 - 1> if T390 is running:
 - 2> stop timer T390 for all access categories;
 - 2> perform the actions as specified in 5.3.14.4;
 - 1> start timer [T301];
 - 1> initiate the PC5 unicast link establishment as specified in TS 23.304 [x1];
 - 1> apply the specified configuration of SL-RLC0 as specified in 9.1.1.4;
 - 1> initiate transmission of the RRCReestablishmentRequest message in accordance with 5.3.7.4.
- 5.3.7.4 Actions Related to Transmission of RRCReestablishmentRequest Message

The UE shall set the contents of RRCReestablishmentRequest message as follows:

 - 1> if the procedure was initiated due to radio link failure as specified in 5.3.10.3 or reconfiguration with sync failure as specified in 5.3.5.8.3:
 - 2> set the reestablishmentCellId in the VarRLF-Report to the global cell identity of the selected cell;
 - 1> set the ue-Identity as follows:
 - 2> set the c-RNTI to the C-RNTI used in the source PCell (reconfiguration with sync or mobility from NR failure) or used in the PCell in which the trigger for the re-establishment occurred (other cases);
 - 2> set the physCellId to the physical cell identity of the source PCell (reconfiguration with sync or mobility from NR failure) or of the PCell in which the trigger for the re-establishment occurred (other cases);
 - 2> set the shortMAC-I to the 16 least significant bits of the MAC-I calculated:
 - 3> over the ASN.1 encoded as per clause 8 (i.e., a multiple of 8 bits) VarShortMAC-Input;
 - 3> with the K_{RRCint} key and integrity protection algorithm that was used in the source PCell (reconfiguration with sync or mobility from NR failure) or of the PCell in which the trigger for the re-establishment occurred (other cases); and
 - 3> with all input bits for COUNT, BEARER and DIRECTION set to binary ones;
 - 1> set the reestablishmentCause as follows:
 - 2> if the re-establishment procedure was initiated due to reconfiguration failure as specified in 5.3.5.8.2:
 - 3> set the reestablishmentCause to the value reconfigurationFailure;
 - 2> else if the re-establishment procedure was initiated due to reconfiguration with sync failure as specified in 5.3.5.8.3 (intra-NR handover failure) or 5.4.3.5 (inter-RAT mobility from NR failure):
 - 3> set the reestablishmentCause to the value handoverFailure;

- 2> else:
 3> set the reestablishmentCause to the value other-Failure;
 1> re-establish PDCP for SRB1;
 1> if the UE connects with a L2 U2N Relay UE via PC5-RRC connection (i.e. the UE is a L2 U2N Remote UE):
 2> apply the default configuration of SL-RLC1 as defined in 9.2.x for SRB1;
 1> else:
 2> re-establish RLC for SRB1;
 2> apply the default configuration defined in 9.2.1 for SRB1;
 1> configure lower layers to suspend integrity protection and ciphering for SRB1;
 NOTE: Ciphering is not applied for the subsequent RRCReestablishment message used to resume the connection. An integrity check is performed by lower layers, but merely upon request from RRC.
 1> resume SRB1;
 1> submit the RRCReestablishmentRequest message to lower layers for transmission.

Next Modified Subclause

5.8.9 Sidelink RRC Procedure

5.8.9.1 Sidelink RRC Reconfiguration

5.8.9.1.1 General

[. . .]

The purpose of this procedure is to modify a PC5-RRC connection, e.g. to establish/modify/release sidelink DRBs, to (re-)configure NR sidelink measurement and reporting, to (re-)configure sidelink CSI reference signal resources and CSI reporting latency bound.

The UE may initiate the sidelink RRC reconfiguration procedure and perform the operation in sub-clause 5.8.9.1.2 on the corresponding PC5-RRC connection in following cases:

- the release of sidelink DRBs associated with the peer UE, as specified in sub-clause 5.8.9.1a.1;
- the establishment of sidelink DRBs associated with the peer UE, as specified in sub-clause 5.8.9.1a.2;
- the modification for the parameters included in SLRB-Config of sidelink DRBs associated with the peer UE, as specified in sub-clause 5.8.9.1a.2;
- the release of sidelink RLC bearers not associated with SL-PDCP for L2 U2N Relay UE and Remote UE, as specified in sub-clause 5.8.9.x1.1;
- the establishment of RLC bearers not associated with SL-PDCP for L2 U2N Relay UE and Remote UE, as specified in sub-clause 5.8.9.x1.2;
- the modification for the parameters included in SL-RLC-BearerConfig of RLC bearers not associated with SL-PDCP for L2 U2N Relay UE and Remote UE, as specified in sub-clause 5.8.9.x1.2;
- the (re-)configuration of the peer UE to perform NR sidelink measurement and report.
- the (re-)configuration of the sidelink CSI reference signal resources and CSI reporting latency bound.

In RRC_CONNECTED, the UE applies the NR sidelink communications parameters provided in RRCReconfiguration (if any). In RRC_IDLE or RRC_INACTIVE, the UE applies the NR sidelink communications parameters provided in system information (if any). For other cases, UEs apply the NR sidelink communications parameters provided in SidelinkPreconfigNR (if any). When UE performs state transition between above three cases, the UE applies the NR

sidelink communications parameters provided in the new state, after acquisition of the new configurations. Before acquisition of the new configurations, UE continues applying the NR sidelink communications parameters provided in the old state.

Next Modified Subclause

5.8.9.3 Sidelink radio link failure related actions

The UE shall:

- 1> upon indication from sidelink RLC entity that the maximum number of retransmissions for a specific destination has been reached; or
- 1> upon T400 expiry for a specific destination; or
- 1> upon indication from MAC entity that the maximum number of consecutive HARQ DTX for a specific destination has been reached; or
- 1> upon integrity check failure indication from sidelink PDCP entity concerning SL-SRB2 or SL-SRB3 for a specific destination:
 - 2> consider sidelink radio link failure to be detected for this destination;
 - 2> release the DRBs of this destination, in according to sub-clause 5.8.9.1a.1 if any;
 - 2> release the SRBs of this destination, in according to sub-clause 5.8.9.1a.3;
 - 2> release the sidelink RLC bearers not associated with SL-PDCP of this destination, in according to sub-clause 5.8.9.x1.1;
 - 2> discard the NR sidelink communication related configuration of this destination;
 - 2> reset the sidelink specific MAC of this destination;
 - 2> consider the PC5-RRC connection is released for the destination;
 - 2> indicate the release of the PC5-RRC connection to the upper layers for this destination (i.e. PC5 is unavailable);
- 2> if UE is in RRC_CONNECTED:
 - 3> perform the sidelink UE information for NR sidelink communication procedure, as specified in 5.8.3.3;
 - 3> if the UE connects with a L2 U2N Relay UE via PC5-RRC connection (i.e. the UE is a L2 U2N Remote UE):
 - 4> initiate the RRC connection re-establishment procedure as specified in 5.3.7.

NOTE: It is up to UE implementation on whether and how to indicate to upper layers to maintain the keep-alive procedure [55].

Next Modified Subclause(New)

5.8.9.x1 Sidelink RLC Bearer Management for L2 U2N Relay

5.8.9.x1.1 Sidelink RLC Bearer Release The UE shall:

- 1> for each sl-RLC-BearerConfigIndex included in the received sl-RLC-BearerToReleaseList that is part of the current UE sidelink configuration:
- 2> release the RLC entity and the corresponding logical channel for NR sidelink communication, associated with the sl-RLC-BearerConfigIndex;

5.8.9.x1.2 Sidelink RLC Bearer Addition/Modification

For each sl-RLC-BearerConfigIndex received in the sl-RLC-BearerToAddModList IE the UE shall:

- 1> if the current configuration contains a sidelink RLC bearer with the received sl-RLC-BearerConfigIndex:
 - 2> reconfigure the sidelink RLC entity or entities in accordance with the received sl-RLC-ConfigPC5;
 - 2> reconfigure the sidelink logical channel in accordance with the received sl-MAC-LogicalChannelConfigPC5;
- 1> else (a sidelink RLC bearer with the received sl-RLC-BearerConfigIndex was not configured before):
 - 2> establish an sidelink RLC entity in accordance with the received sl-RLC-ConfigPC5;
 - 2> configure the sidelink MAC entity with a logical channel in accordance with the received sl-MAC-LogicalChannelConfigPC5.

Editor's Note: RAN2 to further discuss whether new or existing PC-5 RRC message is used for RRC_IDLE/RRC_INACTIVE Remote UE to provide 5G-S-TMSI/I-RNTI as well as interested SIB type to Relay UE.

Editor's note: FFS how to capture the case of Relay UE in RRC_CONNECTED for paging monitoring.

Editor's Note: RAN2 to further discuss whether new or existing PC-5 RRC message is used for SI forwarding.

Next Modified Subclause

9.1.1.4 SCCH Configuration

[. . .]

Parameters that are specified for NR sidelink L2 U2N Relay operations, which is used for the sidelink RLC channel for Remote UE's SRB0 message transmission. The sidelink RLC bearer using this configuration is named as SL-RLC0.

Name	Value	Semantics description	Ver
RLC configuration		AM	
>sn-FieldLength	12		
>t-Reassembly	Undefined	Selected by the receiving UE, up to UE implementation	
>logicalChannelIdentity	FFS		
MAC configuration			
>priority	1		
>prioritisedBitRate	Infinity		
>logicalChannelGroup	0		

Next Modified Subclause

9.2.x Default Sidelink RLC Bearer Configuration

Parameters that are used for the sidelink RLC bearer for Remote UE's SRB1 RRC message such as RRCResume and RRCReestablishment message. The sidelink RLC bearer using this configuration is named as SL-RLC1.

Name	Value	Semantics description	Ver
RLC configuration		AM	
>sn-FieldLength	12		
>t-Reassembly	Undefined	Selected by the receiving UE, up to UE implementation	
>logicalChannelIdentity	FFS		
MAC configuration			
>priority	1		
>prioritisedBitRate	Infinity		
>logicalChannelGroup	0		

According to 3GPP TS 23.304, 5G ProSe Layer-2 UE-to-Network Relay is introduced to provide the relaying functionality to support connectivity to the network for 5G ProSe Remote UEs. When a remote UE initiates a service having traffic toward to network, the remote UE should establish a unicast link or a PC5-S connection with a relay UE. Basically, the remote UE could send a Direct Communication Request message for requesting establishment of the unicast link to the relay UE with the remote UE's Layer 2 Identification (L2ID) as Source L2ID and the relay UE's L2ID as Destination L2ID. The relay UE can learn the remote UE's L2ID by receiving the Direct Communication Request message with the remote UE's L2ID as Source L2ID. On the other hand, the remote UE could establish a first unicast link (for relaying) with the relay UE while the remote UE could establish a second unicast link (for non-relaying) with a non-relay UE.

According to 3GPP TS 38.331, a procedure for sending SidelinkUEInformation message is introduced for UE to request gNB for assignment of transmission resource. For example, when UE1 establishes a unicast link with UE2 and UE1 is in RRC_CONNECTED, UE1 will send a first SidelinkUEInformation message (including UE2's L2ID in destination list) to gNB. According to the first SidelinkUEInformation message, gNB may then configure UE1 with PC5 AS configuration (e.g. Sidelink (SL) Data Radio Bearer (DRB) configuration, SL Service Data Adaptation Protocol (SDAP) configuration, SL RLC configuration, and/or etc.) for UE1 to perform sidelink communication with UE2.

3GPP TS 38.331 also introduces Sidelink RRC procedure for handling Sidelink Radio Link Failure (SL RLF) between two UEs (e.g. UE1 and UE2). That is, when UE1 detects SL RLF corresponding to UE2, UE1 will release the related PC5 transmission resources (including e.g. the SL DRBs, SL SRBs, etc.) and then indicate upper layer of UE1 that PC5 Radio Resource Control (PC5-RRC) connection for UE2 is not available. Since UE2 is not available to UE1, UE1 could send a second SidelinkUEInformation message to gNB for updating the destination list (e.g. exclude UE2's L2ID from the updated destination list) so that gNB can configure UE1 to release the related PC5 AS configuration.

In UE-to-Network (U2N) Relay, according to [3] the 3GPP email discussion [Post115-e][603][Relay] Relaying CR to 38.331 ("Draft_38331 Running CR for SL relay_v14_rapp.docx"), if the remote UE detects SL RLF for any destination while the remote UE in RRC_CONNECTED connects with the relay UE, the remote UE should firstly perform the Sidelink UE Information procedure and then initiate the RRC connection re-establishment procedure. In fact, the condition introduced in the 3GPP email discussion [Post115-e][603][Relay] Relaying CR to 38.331 to trigger the RRC connection re-establishment procedure is also true if the remote UE detects SL RLF on the non-relay UE (instead of the relay UE). In this situation, the remote UE could incorrectly perform the RRC connection re-establishment procedure due to the SL RLF on the non-relay UE since there is no problem on the RRC connection with gNB.

To address the issue, the remote UE could initiate or perform the RRC connection re-establishment procedure (only) if/after/when/upon/in case the destination for the SL RLF is the relay UE. Or, the remote UE could (only) initiate or perform the RRC connection re-establishment procedure in response to detection of SL RLF on the relay UE. The remote UE could not initiate or perform the RRC connection re-establishment procedure if/after/when/upon/in case the destination for the SL RLF is the non-relay UE. Or, the

remote UE could not initiate or perform the RRC connection re-establishment procedure in response to detection of SL RLF on the non-relay UE.

On the other hand, according to the 3GPP email discussion [Post115-e][603][Relay] Relaying CR to 38.331, the remote UE could generate a SidelinkUEInformation message (including destination list in which the relay UE's L2ID is removed) in the firstly performed Sidelink UE Information procedure. Since the remote UE may disconnect from the relay UE due to the SL RLF on the relay UE, the remote UE is not able to send the SidelinkUEInformation message immediately. Thus, the remote UE could buffer the SidelinkUEInformation message in lower layer of the remote UE.

Since the remote UE may select a new relay UE during the RRC connection re-establishment procedure, after the RRC connection re-establishment procedure is completed, the remote UE still needs to send a new SidelinkUEInformation message (including destination list in which the new relay UE's L2ID is included) to gNB via the new relay UE. In this situation, the previously buffered SidelinkUEInformation message (not including the relay UE's L2ID) and the new SidelinkUEInformation message (not including the relay UE's L2ID but including the new relay UE's L2ID) will be sent to gNB via the new relay UE. Actually, the transmission of the previously buffered SidelinkUEInformation message is not needed. To avoid the unnecessary transmission, the remote UE could not initiate or perform the Sidelink UE Information procedure if/after/when/upon/in case the destination for the SL RLF is the relay UE. Or, the remote UE could not initiate or perform the Sidelink UE Information procedure in response to detection of SL RLF on the relay UE. The remote UE could still initiate or perform the Sidelink UE Information procedure for other cases (e.g. the destination for the SL RLF is the non-relay UE).

Here are some potential text proposals:

Proposal 1

5.8.9.3 Sidelink Radio Link Failure Related Actions

The UE shall:

- 1> upon indication from sidelink RLC entity that the maximum number of retransmissions for a specific destination has been reached; or
- 1> upon T400 expiry for a specific destination; or
- 1> upon indication from MAC entity that the maximum number of consecutive HARQ DTX for a specific destination has been reached; or
- 1> upon integrity check failure indication from sidelink PDCP entity concerning SL-SRB2 or SL-SRB3 for a specific destination:
 - 2> consider sidelink radio link failure to be detected for this destination;
 - 2> release the DRBs of this destination, in according to sub-clause 5.8.9.1a.1 if any;
 - 2> release the SRBs of this destination, in according to sub-clause 5.8.9.1a.3;
 - 2> release the sidelink RLC bearers not associated with SL-PDCP of this destination, in according to sub-clause 5.8.9.x1.1;
 - 2> discard the NR sidelink communication related configuration of this destination;
 - 2> reset the sidelink specific MAC of this destination;
 - 2> consider the PC5-RRC connection is released for the destination;
 - 2> indicate the release of the PC5-RRC connection to the upper layers for this destination (i.e. PC5 is unavailable);

2> if UE is in RRC_CONNECTED:

- 3> perform the sidelink UE information for NR sidelink communication procedure, as specified in 5.8.3.3;
- 3> if the destination for the sidelink radio link failure is a L2 U2N Relay UE:
 - 4> initiate the RRC connection re-establishment procedure as specified in 5.3.7.

Proposal 2

5.8.9.3 Sidelink Radio Link Failure Related Actions

The UE shall:

- 1> upon indication from sidelink RLC entity that the maximum number of retransmissions for a specific destination has been reached; or
- 1> upon T400 expiry for a specific destination; or
- 1> upon indication from MAC entity that the maximum number of consecutive HARQ DTX for a specific destination has been reached; or
- 1> upon integrity check failure indication from sidelink PDCP entity concerning SL-SRB2 or SL-SRB3 for a specific destination:
 - 2> consider sidelink radio link failure to be detected for this destination;
 - 2> release the DRBs of this destination, in according to sub-clause 5.8.9.1a.1 if any;
 - 2> release the SRBs of this destination, in according to sub-clause 5.8.9.1a.3;
 - 2> release the sidelink RLC bearers not associated with SL-PDCP of this destination, in according to sub-clause 5.8.9.x1.1;
 - 2> discard the NR sidelink communication related configuration of this destination;
 - 2> reset the sidelink specific MAC of this destination;
 - 2> consider the PC5-RRC connection is released for the destination;
 - 2> indicate the release of the PC5-RRC connection to the upper layers for this destination (i.e. PC5 is unavailable);
- 2> if UE is in RRC_CONNECTED:
 - 3> if the destination for the sidelink radio link failure is a L2 U2N Relay UE:
 - 4> initiate the RRC connection re-establishment procedure as specified in 5.3.7.3> else:
 - 4> perform the sidelink UE information for NR sidelink communication procedure, as specified in 5.8.3.3.

FIG. 13 is a flow chart 1300 from the perspective of a remote UE. In step 1305, the remote UE establishes a first unicast link with a relay UE. In step 1310, the remote UE establishes a RRC connection with a network node via the relay UE. In step 1315, the remote UE establishes a second unicast link with a second UE. In step 1320, the remote UE detects a sidelink radio link failure. In step 1325, the remote UE initiates or performs a RRC connection re-establishment procedure if the sidelink radio link failure occurs on the first unicast link. In step 1330, the remote UE initiates or performs a Sidelink UE Information procedure if the sidelink radio link failure occurs on the second unicast link.

In one embodiment, the remote UE could initiate or perform no RRC connection re-establishment procedure if the sidelink radio link failure occurs on the second unicast link. The remote UE could initiate or perform no Sidelink UE Information procedure if the sidelink radio link failure occurs on the first unicast link.

In one embodiment, the first unicast link could be used for forwarding traffic between the network node and the remote UE via the relay UE. The network node could be a base station or a gNB.

In one embodiment, the second unicast link could be used for transferring traffic between the remote UE and the second UE. The second UE could be a non-relay UE.

In one embodiment, the first unicast link could be associated with a Proximity-based Services (ProSe) Relay Code. The second unicast link may not be associated with any Proximity-based Services (ProSe) Relay Code.

Referring back to FIGS. 3 and 4, in one exemplary embodiment of a method for a remote UE, the remote UE **300** includes a program code **312** stored in the memory **310**. The CPU **308** could execute program code **312** to enable the remote UE (i) to establish a first unicast link with a relay UE, (ii) to establish a RRC connection with a network node via the relay UE, (iii) to establish a second unicast link with a second UE, (iv) to detect a sidelink radio link failure, (v) to initiate or perform a RRC connection re-establishment procedure if the sidelink radio link failure occurs on the first unicast link, and (vi) to initiate or perform a Sidelink UE Information procedure if the sidelink radio link failure occurs on the second unicast link. Furthermore, the CPU **308** can execute the program code **312** to perform all of the above-described actions and steps or others described herein.

FIG. 14 is a flow chart **1400** from the perspective of a remote UE. In step **1405**, the remote UE establishes a first unicast link with a relay UE. In step **1410**, the remote UE establishes a RRC connection with a network node via the relay UE. In step **1415**, the remote UE establishes a second unicast link with a second UE. In step **1420**, the remote UE detects a sidelink radio link failure. In step **1425**, the remote UE initiates or performs a RRC connection re-establishment procedure if the sidelink radio link failure occurs on the first unicast link. In step **1430**, the remote UE initiates or performs no RRC connection re-establishment procedure if the sidelink radio link failure occurs on the second unicast link.

In one embodiment, the remote UE could initiate or perform a Sidelink UE Information procedure if the sidelink radio link failure occurs on the second unicast link. The remote UE could initiate or perform no Sidelink UE Information procedure if the sidelink radio link failure occurs on the first unicast link.

Referring back to FIGS. 3 and 4, in one exemplary embodiment of a method for a remote UE, the remote UE **300** includes a program code **312** stored in the memory **310**. The CPU **308** could execute program code **312** to enable the remote UE (i) to establish a first unicast link with a relay UE, (ii) to establish a RRC connection with a network node via the relay UE, (iii) to establish a second unicast link with a second UE, (iv) to detect a sidelink radio link failure, (v) to initiate or perform a RRC connection re-establishment procedure if the sidelink radio link failure occurs on the first unicast link, and (vi) to initiate or perform no RRC connection re-establishment procedure if the sidelink radio link failure occurs on the second unicast link. Furthermore, the CPU **308** can execute the program code **312** to perform all of the above-described actions and steps or others described herein.

FIG. 15 is a flow chart **1500** from the perspective of a remote UE. In step **1505**, the remote UE establishes a first unicast link with a relay UE. In step **1510**, the remote UE establishes a RRC connection with a network node via the relay UE. In step **1515**, the remote UE establishes a second

unicast link with a second UE. In step **1520**, the remote UE detects a sidelink radio link failure. In step **1525**, the remote UE initiates or performs a Sidelink UE Information procedure if the sidelink radio link failure occurs on the second unicast link. In step **1525**, the remote UE initiates or performs no Sidelink UE Information procedure if the sidelink radio link failure occurs on the first unicast link.

In one embodiment, the remote UE could initiate or perform a RRC connection re-establishment procedure if the sidelink radio link failure occurs on the first unicast link. The remote UE could initiate or perform no RRC connection re-establishment procedure if the sidelink radio link failure occurs on the second unicast link.

Referring back to FIGS. 3 and 4, in one exemplary embodiment of a method for a remote UE, the remote UE **300** includes a program code **312** stored in the memory **310**. The CPU **308** could execute program code **312** to enable the remote UE (i) to establish a first unicast link with a relay UE, (ii) to establish a RRC connection with a network node via the relay UE, (iii) to establish a second unicast link with a second UE, (iv) to detect a sidelink radio link failure, (v) to initiate or perform a Sidelink UE Information procedure if the sidelink radio link failure occurs on the second unicast link, and (vi) to initiate or perform no Sidelink UE Information procedure if the sidelink radio link failure occurs on the first unicast link. Furthermore, the CPU **308** can execute the program code **312** to perform all of the above-described actions and steps or others described herein.

In the context of the embodiments shown in FIGS. 14 and 15 and discussed above, in one embodiment, the remote UE could transmit a first RRC message to the network node via the relay UE for request of establishing the RRC connection. The remote UE could receive a second RRC message from the first network node via the relay UE for establishing the RRC connection. The remote UE could transmit a third RRC message to the first network node via the relay UE for completing establishment of the RRC connection.

In one embodiment, the network node could be a base station or a gNB. The first RRC message could be a RRCSetupRequest message. The second RRC message could be a RRCSetup message. The third RRC message could be a RRCSetupComplete message.

In one embodiment, the first unicast link could be associated with a ProSe Relay Code. The second unicast link may not be associated with any ProSe Relay Code. The first unicast link could be used for forwarding traffic between the network node and the remote UE via the relay UE. The second unicast link could be used for transferring traffic between the remote UE and the second UE.

In one embodiment, the second UE could be a non-relay UE.

Various aspects of the disclosure have been described above. It should be apparent that the teachings herein could be embodied in a wide variety of forms and that any specific structure, function, or both being disclosed herein is merely representative. Based on the teachings herein one skilled in the art should appreciate that an aspect disclosed herein could be implemented independently of any other aspects and that two or more of these aspects could be combined in various ways. For example, an apparatus could be implemented or a method could be practiced using any number of the aspects set forth herein. In addition, such an apparatus could be implemented or such a method could be practiced using other structure, functionality, or structure and functionality in addition to or other than one or more of the aspects set forth herein. As an example of some of the above concepts, in some aspects concurrent channels could be

established based on pulse repetition frequencies. In some aspects concurrent channels could be established based on pulse position or offsets. In some aspects concurrent channels could be established based on time hopping sequences. In some aspects concurrent channels could be established based on pulse repetition frequencies, pulse positions or offsets, and time hopping sequences.

Those of skill in the art would understand that information and signals may be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits, symbols, and chips that may be referenced throughout the above description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof.

Those of skill would further appreciate that the various illustrative logical blocks, modules, processors, means, circuits, and algorithm steps described in connection with the aspects disclosed herein may be implemented as electronic hardware (e.g., a digital implementation, an analog implementation, or a combination of the two, which may be designed using source coding or some other technique), various forms of program or design code incorporating instructions (which may be referred to herein, for convenience, as “software” or a “software module”), or combinations of both. To clearly illustrate this interchangeability of hardware and software, various illustrative components, blocks, modules, circuits, and steps have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. Skilled artisans may implement the described functionality in varying ways for each particular application, but such implementation decisions should not be interpreted as causing a departure from the scope of the present disclosure.

In addition, the various illustrative logical blocks, modules, and circuits described in connection with the aspects disclosed herein may be implemented within or performed by an integrated circuit (“IC”), an access terminal, or an access point. The IC may comprise a general purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, electrical components, optical components, mechanical components, or any combination thereof designed to perform the functions described herein, and may execute codes or instructions that reside within the IC, outside of the IC, or both. A general purpose processor may be a microprocessor, but in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

It is understood that any specific order or hierarchy of steps in any disclosed process is an example of a sample approach. Based upon design preferences, it is understood that the specific order or hierarchy of steps in the processes may be rearranged while remaining within the scope of the present disclosure. The accompanying method claims present elements of the various steps in a sample order, and are not meant to be limited to the specific order or hierarchy presented.

The steps of a method or algorithm described in connection with the aspects disclosed herein may be embodied directly in hardware, in a software module executed by a processor, or in a combination of the two. A software module (e.g., including executable instructions and related data) and other data may reside in a data memory such as RAM memory, flash memory, ROM memory, EPROM memory, EEPROM memory, registers, a hard disk, a removable disk, a CD-ROM, or any other form of computer-readable storage medium known in the art. A sample storage medium may be coupled to a machine such as, for example, a computer/processor (which may be referred to herein, for convenience, as a “processor”) such the processor can read information (e.g., code) from and write information to the storage medium. A sample storage medium may be integral to the processor. The processor and the storage medium may reside in an ASIC. The ASIC may reside in user equipment. In the alternative, the processor and the storage medium may reside as discrete components in user equipment. Moreover, in some aspects any suitable computer-program product may comprise a computer-readable medium comprising codes relating to one or more of the aspects of the disclosure. In some aspects a computer program product may comprise packaging materials.

While the invention has been described in connection with various aspects, it will be understood that the invention is capable of further modifications. This application is intended to cover any variations, uses or adaptation of the invention following, in general, the principles of the invention, and including such departures from the present disclosure as come within the known and customary practice within the art to which the invention pertains.

The invention claimed is:

1. A method for a remote User Equipment (UE), comprising:
 - establishing a first unicast link with a relay UE;
 - establishing a Radio Resource Control (RRC) connection with a network node via the relay UE;
 - establishing a second unicast link with a second UE;
 - detecting a sidelink radio link failure;
 - initiating or performing a RRC connection re-establishment procedure in response to the sidelink radio link failure on the first unicast link, wherein the remote UE in the RRC connection re-establishment procedure performs a relay selection and/or a cell selection; and
 - initiating or performing a Sidelink UE Information procedure in response to the sidelink radio link failure on the second unicast link, wherein the remote UE in the Sidelink UE Information procedure sends a Sidelink UE Information message to the network node to indicate the sidelink radio link failure on the second UE.
2. The method of claim 1, further comprising:
 - initiating or performing no RRC connection re-establishment procedure if the sidelink radio link failure occurs on the second unicast link.
3. The method of claim 1, further comprising:
 - initiating or performing no Sidelink UE Information procedure if the sidelink radio link failure occurs on the first unicast link.
4. The method of claim 1, wherein the first unicast link is used for forwarding traffic between the network node and the remote UE via the relay UE.
5. The method of claim 4, wherein the network node is a base station or a gNB.
6. The method of claim 1, wherein the second unicast link is used for transferring traffic between the remote UE and the second UE.

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7. The method of claim 6, wherein the second UE is a non-relay UE.

8. The method of claim 1, wherein the first unicast link is associated with a Proximity-based Services (ProSe) Relay Code.

9. The method of claim 1, wherein the second unicast link is not associated with any Proximity-based Services (ProSe) Relay Code.

10. A remote UE (User Equipment), comprising:

a control circuit;

a processor installed in the control circuit; and

a memory installed in the control circuit and operatively coupled to the processor;

wherein the processor is configured to execute a program code stored in the memory to:

establish a first unicast link with a relay UE;

establish a Radio Resource Control (RRC) connection with a network node via the relay UE;

establish a second unicast link with a second UE;

detect a sidelink radio link failure;

initiate or perform a RRC connection re-establishment procedure in response to the sidelink radio link failure on the first unicast link, wherein the remote UE in the RRC connection re-establishment procedure performs a relay selection and/or a cell selection; and

initiate or perform a Sidelink UE Information procedure in response to the sidelink radio link failure on the second unicast link, wherein the remote UE in the

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Sidelink UE Information procedure sends a Sidelink UE Information message to the network node to indicate the sidelink radio link failure on the second UE.

11. The remote UE of claim 10, further comprising: initiating or performing no RRC connection re-establishment procedure if the sidelink radio link failure occurs on the second unicast link.

12. The remote UE of claim 10, further comprising:

initiating or performing no Sidelink UE Information procedure if the sidelink radio link failure occurs on the first unicast link.

13. The remote UE of claim 10, wherein the first unicast link is used for forwarding traffic between the network node and the remote UE via the relay UE.

14. The remote UE of claim 13, wherein the network node is a base station or a gNB.

15. The remote UE of claim 10, wherein the second unicast link is used for transferring traffic between the remote UE and the second UE.

16. The remote UE of claim 15, wherein the second UE is a non-relay UE.

17. The remote UE of claim 10, wherein the first unicast link is associated with a Proximity-based Services (ProSe) Relay Code.

18. The remote UE of claim 10, wherein the second unicast link is not associated with any Proximity-based Services (ProSe) Relay Code.

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